RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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Vol. 60 JUNE 1953 No. 6

The Right Anterior Oblique Projection in the Angiocardiographic Demonstration of Infundibular Stenosis[1]

SUMNER N. MARDER, M.D.,[2] and WENDELL G. SCOTT, M.D.

St. Louis, Mo.

AT THE PRESENT time, pulmonic stenosis is the most important single criterion in the evaluation of patients with cyanotic congenital malformations of the heart for the selection of those who may benefit from surgical measures. Furthermore, the accurate delineation of the infundibular portion of the right ventricle by angiocardiographic study may be of value in determining whether an aorticopulmonary anastomosis (1, 2) or an infundibular resection be undertaken (3).

Dotter and Steinberg (4) have recently estimated that pulmonic stenosis is directly visualized in only one-half the cases of the tetralogy of Fallot. Cooley and his coworkers (5) have also reported that in many of these cases angiocardiography has provided only indirect evidence of pulmonic stenosis.

With the development of biplane serial angiocardiography, which allows simultaneous right-angle exposures, greater precision and flexibility have been introduced into this procedure (6). While the number of cases examined by this technic has been small, the experience to date suggests that the right anterior oblique[3] projection may be of great value in visualizing the infundibular stenosis of the tetralogy of Fallot. Three illustrative cases are reported.

CASE REPORTS

The first case presented is one with a "normal" angiocardiogram. This child was subjected to intensive diagnostic study chiefly at the insistence of her parents, and no significant deviations from normal were noted.

CASE 1: J. N., a 2 1/2-year-old white female, was found to have a cardiac murmur on routine examination. Birth and development had been normal. Neither cyanosis nor restriction of activity had been noticed. Examination showed the child to be well developed and well nourished. A Grade II systolic murmur was audible over the pulmonic area. No other abnormalities were found. The hemogram, electrocardiogram, and conventional roentgenograms were within normal limits. Angiocardiographic examination was carried out with the child supine and positioned to provide right-angle oblique views. Twenty-five c.c. of Urokon Sodium 70%[4] were injected through a right antecubital vein and serial exposures were obtained at half-second intervals (6).

Figures 1 A and B are reproductions of the right anterior oblique angiocardiograms obtained at one

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[2] Deceased.

[3] In order to avoid confusion and to retain the terminology employed in cardiac fluoroscopy and conventional radiography, the term "right anterior oblique view" has been employed throughout this article to denote the projection obtained in supine angiocardiography with the patient in the left posterior oblique position.

[4] The Urokon Sodium 70% was generously supplied by the Mallinckrodt Chemical Works.

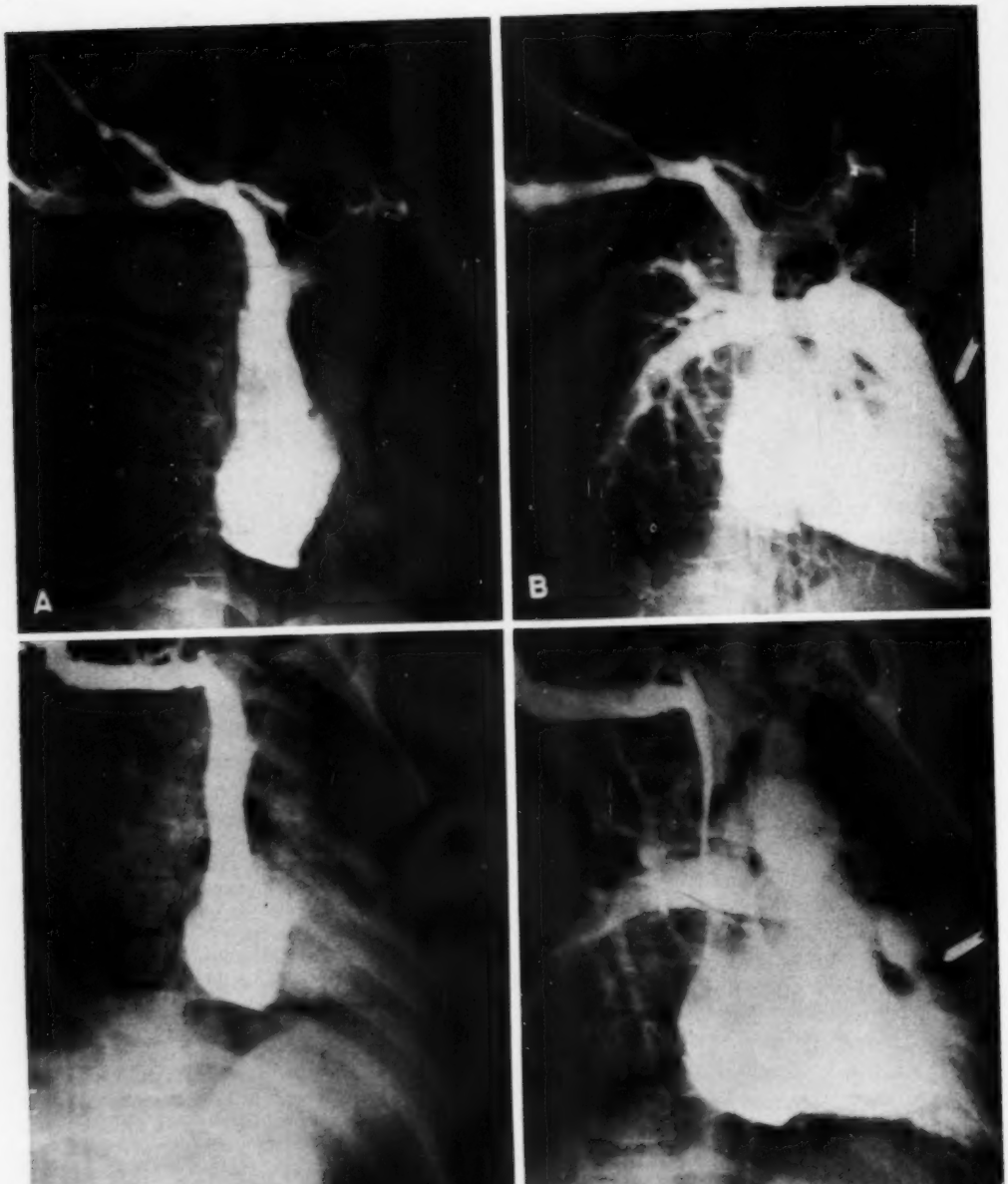

Fig. 1. Right anterior oblique angiocardiograms. Arrows indicate the region of the infundibulum of the right ventricle. A and B. Case 1. No demonstrable abnormalities in right auricle (A), right ventricle, or pulmonary arteries (B). C and D. Case 2. High infundibular stenosis (D, arrow). Note separation of infundibular region and aorta in this projection. The pulmonary arteries beyond the stenotic area appear of normal caliber.

and three seconds after injection. Sequential filling of the right auricle, right ventricle, and pulmonary arteries was demonstrated. Figures 2 A and B are corresponding films obtained in the left anterior oblique projection. No anatomic basis for the cardiac murmur could be demonstrated.

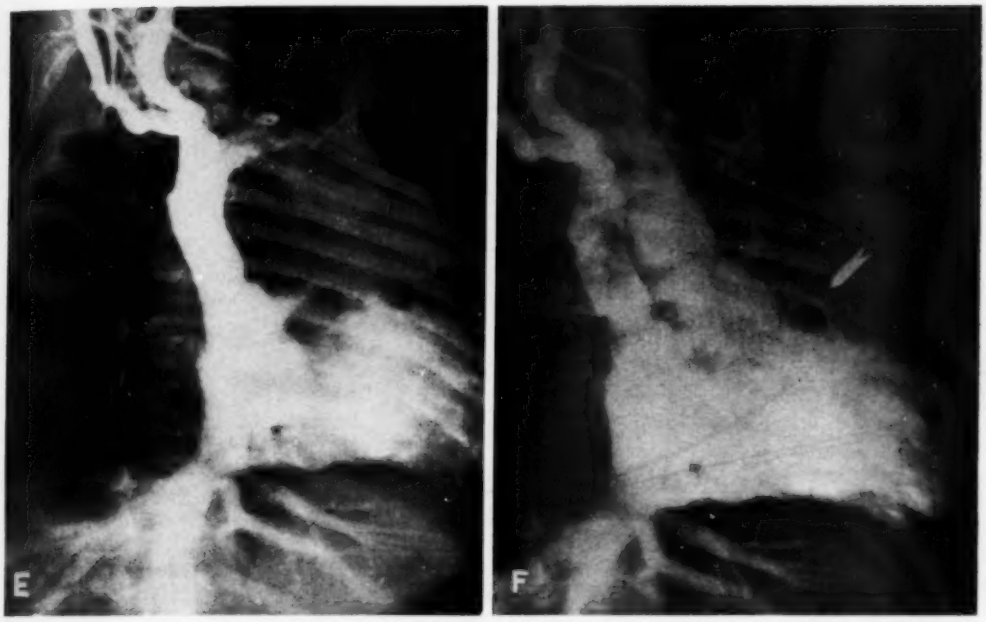

Fig. 1. E and F. Case 3. The hook-shaped infundibulum is well shown in F (arrow). Compare with photograph of specimen (Fig. 3).

CASE 2: D. G., a 5-year-old white female was normal at birth but a "heart condition" was diagnosed at six weeks of age. Mild cyanosis had been noticed after exercise. Development was retarded, and physical activity severely limited. The child tired easily and squatted when tired. Examination showed a poorly developed female with cyanosis limited to the mucous membranes and nail-beds while at rest. Clubbing of all the digits was marked. A Grade IV systolic murmur was heard over the entire precordium and was transmitted to the back. Red blood cells numbered 7,000,000, and the hemoglobin was 19 gm. Unipolar electrocardiograms revealed right ventricular hypertrophy and tall, peaked P waves. Conventional chest films showed the heart to be within normal limits as to size and configuration. The caliber of the intrapulmonary branches of the pulmonary arteries was at the lower limits of normal, but not sufficiently small to be diagnostic of pulmonary stenosis. Angiocardiographic examination was carried out in the manner described above, using 30 c.c. of Urokon Sodium 70%.

At operation, the pulmonary arteries were thought to be of decreased size and pulsation. Following a Brock procedure, the child's color was improved, and the murmur was thought to have decreased in intensity.

The angiographic findings are illustrated in Figures 1 C and D (right anterior oblique) and 2 C and D (left anterior oblique). The infundibular stenosis is seen in Figure 1 D (arrow), and this configuration was clearly identifiable on the next four exposures taken at half-second intervals. In the left anterior oblique view, of which Figure 2 D is representative, the infundibular region is obscured by the aorta which was opacified simultaneously, presumably through an interventricular septal defect (and by virtue of its dextraposition).

CASE 3: M. W., a 1-year-old white male, had been a "blue baby." Cyanosis was persistent at rest and increased with crying. Examination showed moderate cyanosis but no digital clubbing. A Grade II systolic murmur was heard along the left sternal border. The hemogram was normal. The electrocardiogram showed right ventricular hypertrophy. Conventional roentgenograms revealed a somewhat globular heart, which was slightly larger than that usually seen in the tetralogy. The pulmonary arteries were of markedly reduced caliber, and the diagnosis of pulmonary stenosis was made on this basis. Biplane angiocardiography was carried out with 20 c.c. of Neo-Iopax 75%.

At surgery, the pulmonary artery was small and "limp." A Potts-Smith anastomosis was performed. The postoperative course was complicated by atelectasis, and the child died thirty-six hours following operation. At autopsy, the diagnosis of tetralogy of Fallot was confirmed. The right ventricle ended blindly in a narrow infundibulum, which did not communicate with the pulmonary artery (Fig. 3). The pulmonary artery was approximately one-fourth the caliber of the

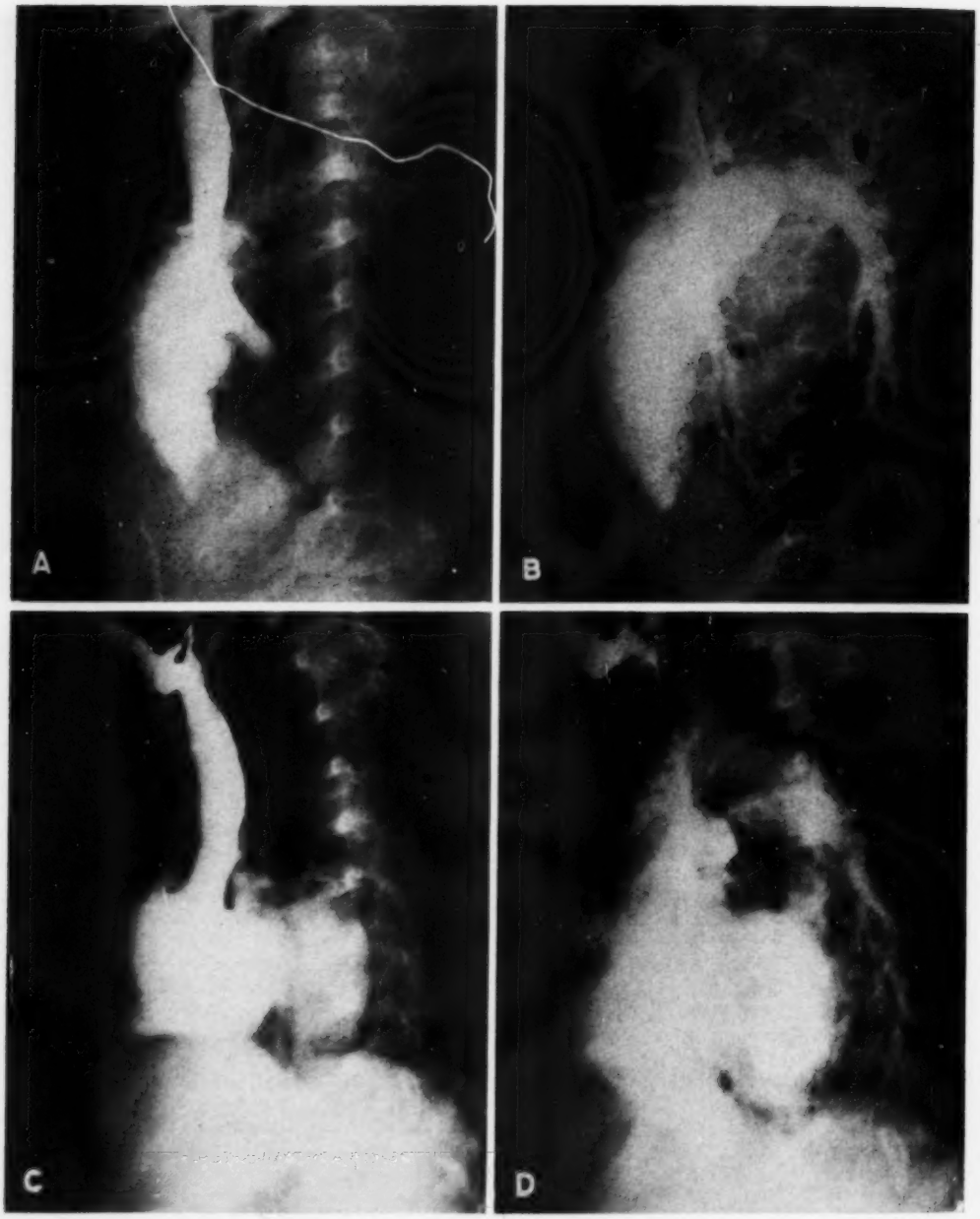

Fig. 2. Left anterior oblique angiocardiograms exposed simultaneously with those of Fig. 1. A and B. Case 1. C and D. Case 2. The infundibulum is obscured by the aorta, which is opacified simultaneously with the pulmonary arteries. Note the opacification of the left ventricle (D), presumably through an interventricular septal defect.

aorta and only one rudimentary valve cusp was identified. The aorta arose from both ventricles directly above a high interventricular septal defect. The ductus arteriosus was in its usual position and its lumen measured 4 mm. at the aortic orifice but less than 1 mm. at its entrance into the pulmonary artery. The surgical anastomosis was patent.

This case illustrates the possibility of predicting

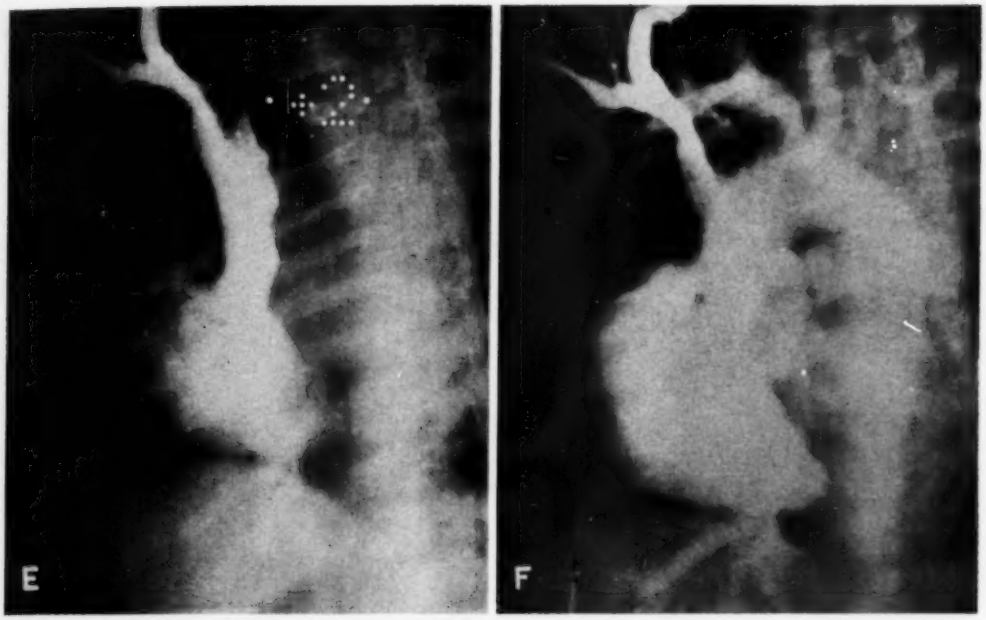

Fig. 2. E and F. Case 3. Both the superior vena cava and the aorta obscure the region of the infundibulum.

Fig. 3. Photograph of autopsy specimen (after fixation) in Case 3. A. The narrow infundibulum ends blindly without communication with the pulmonary artery. B. Right ventricle. C. Interventricular septal defect.

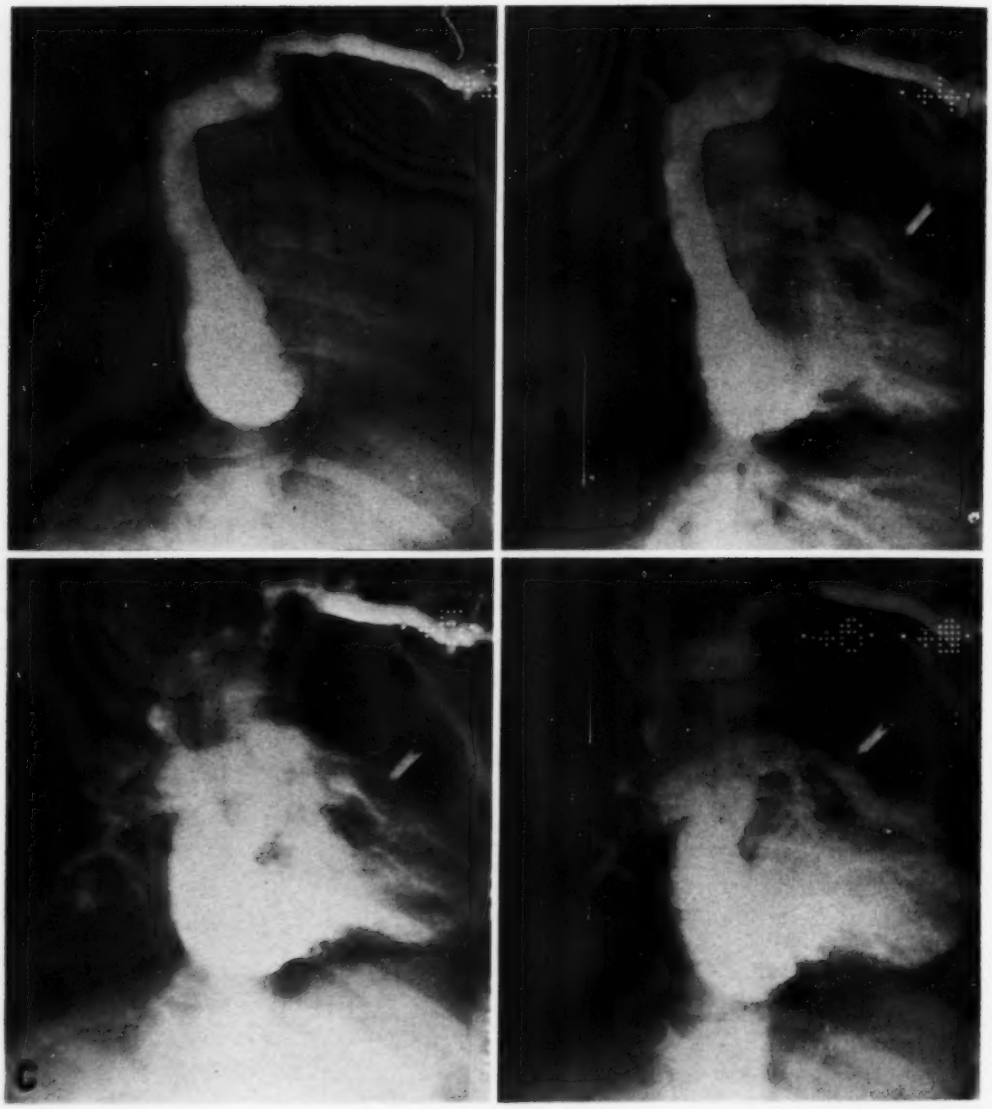

Fig. 4. Angiocardiograms in Case 4 at a slight degree of obliquity. Note the changes in the long, narrow infundibulum (arrows) due to systole (C) and diastole (B and D).

preoperatively that the infundibular stenosis is not anatomically suited for a Brock procedure. The angiocardiograms (Figs. 1 E and F and 2 E and F) revealed the true nature of the stenosis. As shown by Cooley, *et al.* (5) the failure of the pulmonary arteries to opacify did not preclude the possibility of their being of sufficient caliber to allow a surgical anastomosis.

CASE 4: F. H., a 6-year-old white boy had been cyanotic since birth. Physical development was normal, but the child tired after a few steps and squatted. He was subject to "spells" which consisted of deep cyanosis and unresponsiveness lasting fifteen to thirty minutes and occurring as often as three times per day. There were moderate cyanosis and mild clubbing of all the digits. A Grade III systolic murmur was audible in the left second intercostal space and a thrill was palpable in this area. A hemogram showed 5,000,000 red blood cells, and a hemoglobin of 16.5 gm. Conventional films and fluoroscopy revealed the elevated apex,

concave pulmonary artery segment, clear aortic window, and diminished vascular shadows characteristic of tetralogy of Fallot. Angiocardiographic examination was carried out with 25 c.c. of Neo-Iopax 75% in a single view only. Operation was advised but refused.

The angiocardiograms (Fig. 4) revealed a tubular narrowing of the infundibular portion of the right ventricle and illustrate the changes in the appearance due to systole (Fig. 4 B) and diastole (Fig. 4 C). The appearance of the stenotic area strongly suggests that a direct surgical approach would be less satisfactory than an anastomotic procedure.

DISCUSSION

The left anterior oblique and left lateral views have been widely employed in angiocardiography. These projections "separate" the two sides of the heart and undoubtedly provide the maximum amount of general information. The above cases, however, illustrate that opacification of the superior vena cava and/or the dextraposed aorta may interfere with the accurate visualization of the outflow tract of the right ventricle in these projections.

In conventional radiography, the right anterior oblique view is employed to obtain a "profile" view of the right ventricle and the main pulmonary artery. It is not surprising, therefore, that this projection should provide unobstructed visualization of the infundibulum of the right ventricle. It is fortunate that both oblique projections can be obtained with a single injection of contrast material if biplane angiocardiography is employed.

From the present case material, the degree of obliquity does not appear to be a critical factor. It would seem that sufficient deviation from the frontal plane to avoid superimposition of the dorsal spine and the infundibulum is adequate. This has the advantage that the corresponding left anterior oblique films approach a true lateral projection, which seems desirable in the diagnosis of other features of congenital cardiac malformations such as transposition of the great vessels (7). At the present time, the authors prefer a 5 or 10 degree deviation from true frontal and lateral projections, with the higher degrees of obliquity being employed in the older patients.

It remains to be seen, of course, whether the right anterior oblique projection will consistently provide accurate data in a large percentage of cases. In addition, further correlation with surgical and pathological findings is desirable. However, the case material presented is suggestive and permits the recommendation of this technic for further clinical trial.

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Aneurysm of the Innominate Artery

Review of Clinical and Radiologic Findings in 18 Cases[1]

BRIT B. GAY, JR., M.D.,[2] and J. FRANKLIN WALKER, M.D.[3]

ANEURYSMS OF the innominate artery have interested clinicians for centuries because of their spectacular appearance and course (16). The tendency of this internal aneurysm to present in the neck as a pulsating mass led physicians of the distant past to recognize the condition as a distinct clinical entity, despite the fact that the innominate artery is a relatively uncommon site of aneurysmal formation. Osler (15) stated that only 3 per cent of all aneurysms occur in this location. Kerley (12) found but 6 cases of aneurysm of the innominate artery in 62 cases of intrathoracic aneurysm.

Since the earliest mention in the second century A.D. (16), knowledge of the clinical signs and symptoms of innominate aneurysms has been accumulating in the medical literature. A review of the more recent publications, however, revealed to us the present need for a complete analysis of a series of cases, with particular emphasis on radiographic methods of diagnosis. Rational treatment by the improved surgical technics presupposes an accurate knowledge of the pathologic anatomy and altered physiology associated with an individual aneurysm. In this regard, we will re-emphasize the use of angiocardiography.

MATERIAL

Material for this study was obtained from the files of Lawson VA Hospital, and other Veterans Administration Hospitals in the southeastern area and hospitals affiliated with Emory University School of Medicine (Lawson VA Hospital, Chamblee, Ga., 7 cases; Kennedy VA Hospital, Memphis, Tenn., 6 cases; VA Hospital, Coral Gables, Fla., 1 case; Grady Memorial Hospital, Atlanta, Ga., 3 cases; Emory University Hospital, Emory University, Ga., 1 case). The series comprises 18 cases of aneurysm of the innominate artery. In 9 of these the diagnosis was proved by autopsy, surgical exploration, and/or angiocardiography. The remaining 9 cases were diagnosed by a correlation of clinical and radiologic findings. The original roentgenograms were available for review in all but 1 of the cases.

ETIOLOGY

Syphilis is the most common etiologic agent in innominate aneurysm (9, 21). Pure arteriosclerotic aneurysms are extremely rare; an authenticated case was not discovered in the medical literature. Wolffe (22) reported a case of innominate artery aneurysm associated with coarctation of the aorta and rheumatic heart disease in a seven-year-old white female, without evidence of lues. The child was still living ten years later with little disability. Marked dilatation of the innominate artery usually accompanies coarctation of the aorta (9). One of our cases had no serologic or clinical evidence of syphilis, and this was true also of 1 of 3 cases treated surgically by Rundle (18); the etiology in these cases was not determined.

PATHOLOGY AND CLINICAL FINDINGS

In vascular lues, round-cell infiltration begins in the adventitia and later affects the media with weakening of the wall of the artery. Luetic aortitis always precedes luetic aneurysms of the innominate

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artery. Of 141 cases of luetic aortitis studied by Honig, Steinberg, and Dotter (9), 21 per cent had associated aneurysms of the innominate artery. With this weakening of the media, the vessel dilates.

Rundle divided innominate artery aneurysms into 3 major types: (1) a saccular type affecting the distal part of the vessel and bifurcation; (2) a combined type, affecting the base of the innominate artery and aorta; and (3) a fusiform type, involving the trunk. He believed the latter type to be rare; it tends to progress proximally and distally, and to merge into the other types. As the aneurysm enlarges, its relation to surrounding structures manifests itself clinically in various ways. The formation of a laminated clot within the aneurysm is the rule rather than the exception. Death may be due to rupture or to marked tracheal compression with asphyxia.

An understanding of the gross anatomic relations of the innominate artery serves to clarify *the physical signs and symptoms.* The clinical signs result in large part from pressure on adjacent structures by the expanding mass. The compactness of the important neighboring organs in the relatively small superior mediastinum results in early pressure phenomena (14). On this anatomic basis, we may anticipate pain in the neck, shoulder, arm, or head from pressure on the cervical or brachial plexus of nerves. Accordingly, vascular compression results in radial or right carotid pulse weakness and venous congestion of the face and neck. Cough, hoarseness, and even aphonia result from right recurrent laryngeal nerve pressure. Cough may also be produced by phrenic nerve pressure or by compression of the respiratory tract with resultant irritation and impaired drainage of secretions (11). Abnormalities of the pupils are associated with sympathetic chain pressure, and dyspnea and dysphagia with pressure on the trachea and esophagus, respectively. Some of these clinical findings were difficult to evaluate fully in some patients in our series because of coexisting syphilitic valvular heart disease and cardiac decompensation.

All 18 patients in the present series were males. Thirteen (72 per cent) were colored. The age range was from thirty-five to sixty-three years. Eleven men (61 per cent) were in their sixth decade when first seen. Obvious deficiencies in these figures result from the fact that most of these patients were drawn from a limited segment of the population.

A serological test for syphilis was positive in 14 of the patients (78 per cent); 8 (44 per cent) of these gave a definite history of chancre. These figures are almost identical with those reported by Warfield (21). The period between penile lesion and admission averaged twenty-six years. Only 7 of the 18 had received antiluetic therapy in any form prior to admission, and in several of these treatment was of very recent date. A lumbar puncture was performed in 11 patients, and in 4 the cerebrospinal fluid Wassermann reaction was positive. It is noteworthy that 1 individual presented no clinical or laboratory evidence of syphilis whatsoever.

The most frequent chief complaint was pain, although dyspnea was more commonly found a part of the total symptomatology. This interesting fact was also noted by Kampmeier (11) in his study of 633 cases of saccular aneurysm of the thoracic aorta. Seven of the 18 patients (39 per cent) gave pain as the chief complaint; 4, dyspnea; 2, mass in the neck; and 1, hoarseness. The other 4 patients were admitted to the hospital with chief complaints unrelated to their innominate aneurysms. Of these 4, however, only 1 had an innominate aneurysm producing no symptoms.

As previously mentioned, the symptom most commonly associated with innominate aneurysm is dyspnea, being present in 12 (67 per cent) of our cases. Pain and cough were each observed ten times (56 per cent). Of those with pain, half experienced both local pain and pain radiating to the right shoulder. Two patients had pain of equal intensity in both right

and left shoulders and arms. Shoulder pain in the absence of local pain was noted only twice. Hoarseness and dysphagia were each encountered in 4 cases (22 per cent). In only one patient, however, were these signs found existing together. One patient had marked dysphagia with right vocal cord paralysis.

A pulsating tumor in the neck was found in half our cases of innominate aneurysm. Cervical venous congestion, a sign in 7 patients (39 per cent), was frequently seen in the absence of a palpable mass. Twelve patients (67 per cent) were found to have gross cardiomegaly on physical examination, and 8 of these were in cardiac failure at some time during the period of observation. Murmurs were heard over the precordial area in 10 patients (56 per cent); 8 of these had an aortic diastolic murmur consistent with valvular insufficiency. In addition, 5 patients had associated aortic systolic murmurs; 2 had gross irregularities of cardiac rhythm.

We were surprised to find pupillary abnormalities in 8 (44 per cent) of our cases. Only 1 patient exhibited digital clubbing. Severe coughing in 1 patient was followed by rapid expansion of the palpable neck mass. In only 1 patient was pain absolutely incapacitating. Another patient received complete relief of pain following paravertebral block anesthesia. A particularly fortunate individual experienced a regression of the aneurysmal mass and complete remission of symptoms for twenty years following a full course of antiluetic therapy.

Surgery was performed in 4 of the 18 patients with innominate aneurysm. The aneurysm was wrapped with cellophane or wired in 3 instances. The other patient had surgical decompression by clavicular resection initially, followed by further decompression one year later to relieve tracheal obstruction.

Four of our patients have expired; an autopsy was performed in 3. In only 1 of these was the innominate aneurysm a major contributing factor in the death. In this instance death occurred soon after the partial rupture of the aneurysm into the anterior neck and superior chest wall. The other 2 patients died of miliary tuberculosis and a cerebral vascular accident, respectively. In the patient not examined postmortem it was not determined whether death resulted from a myocardial infarction or rupture of the innominate aneurysm, although the latter was strongly suspected.

Although a spectacular and distinctive clinical course is occasionally encountered, we agree with Warfield that there are no classical symptoms pathognomonic of innominate artery aneurysms (21). A variety of pathologic chest conditions give similar symptoms. On the other hand, we believe that the clinical findings are sufficiently characteristic to suggest strongly the possibility of innominate aneurysm and stimulate further investigation.

RADIOGRAPHIC FINDINGS

All of the 18 cases reported had some type of radiologic examination. In a large percentage of cases an accurate diagnosis of an innominate aneurysm can be made when the clinical, radiographic, and fluoroscopic findings are correlated. As Honig, Steinberg, and Dotter have pointed out (9), however, in some cases elongation and "buckling" of the innominate artery in arteriosclerotic, hypertensive patients simulate aneurysm on routine radiographic and fluoroscopic examination. Angiocardiographic studies are helpful in confirming the diagnosis.

Routine radiographic studies of the chest in our series revealed in the postero-anterior projection *a soft-tissue density in the right paratracheal region* arising at the level of the aortic arch shadow (Figs. 1–4). This mass shadow had smooth margins (with but one exception) which bulged convexly from the mediastinal shadow into the right upper lung field. The superior margin was lost in the soft tissues behind and above the sternoclavicular joint. The *size of the mass* varied from 4 to 8 cm. in width and from 5 to 15 cm. in length. *Peripherally distributed calcium deposits* were present in

7 of the 18 cases (Fig. 4C). *Tracheal displacement* was absent in 5 of 18 cases. Most commonly the mass displaced the trachea to the left and posteriorly (7 of 18 cases) (Figs. 1, 2, 4). Displacement was aneurysms were present in 6 cases. *Calcification in the ascending aorta* occurred in 7 of 18 cases (Fig. 4F); this has been well established as a roentgen sign of luetic aortitis in patients under sixty years (10).

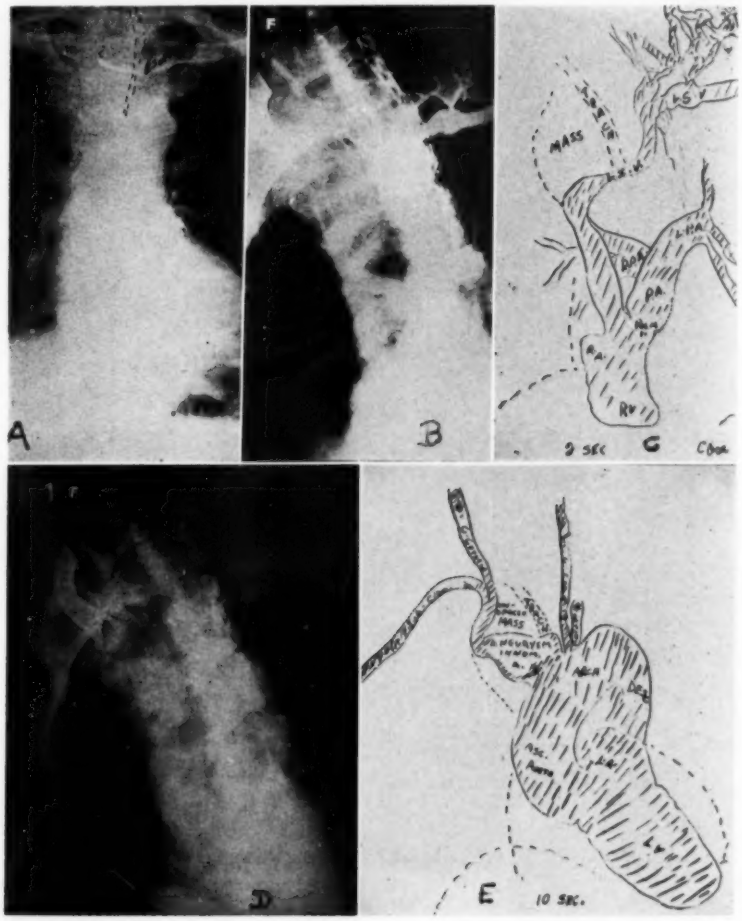

Fig. 1. A. Postero-anterior radiograph of chest showing right superior mediastinal mass producing displacement of esophagus to left (dotted); left ventricle enlarged. B. Angiocardiogram, left anterior oblique projection, two seconds after injection, showing compression of left innominate vein by mass. C. Diagram of Fig. 1 B. D. Angiocardiogram, left anterior oblique projection, ten seconds after injection, showing filling of the left side of heart, general dilatation of the aorta, opacification of the innominate artery aneurysm. Note thickness of wall of aneurysm due to laminated thrombus. E. Diagram of Fig. 1 D.

to the left only in 2 cases, posteriorly only in 3 cases, and posteriorly and to the right in 1 case. The aortic shadow was considered to be normal in 5 cases and diffusely dilated in 7; definite single or multiple aortic

In association with a right superior mediastinal mass it should make one suspect a luetic innominate aneurysm. Warfield (21) states that, to make a diagnosis of innominate aneurysm, one must first estab-

lish the presence of luetic aortitis. The cardiac silhouette was considered normal in 9 cases; there was enlargement of the left ventricle in 7 cases and generalized cardiac enlargement in 2 cases. *Bone erosion* was demonstrated in 3 cases (the anterior extremity of the first right rib, the medial extremity of the right clavicle, and the posterior aspect of the manubrium). One patient had the typical findings of luetic osteomyelitis of the right clavicle (Fig. 4A).

In the lateral and left anterior oblique views the mass was seen anteriorly, bulging into the retrosternal and retromanubrial space. The close relation to the trachea was well demonstrated in these projections.

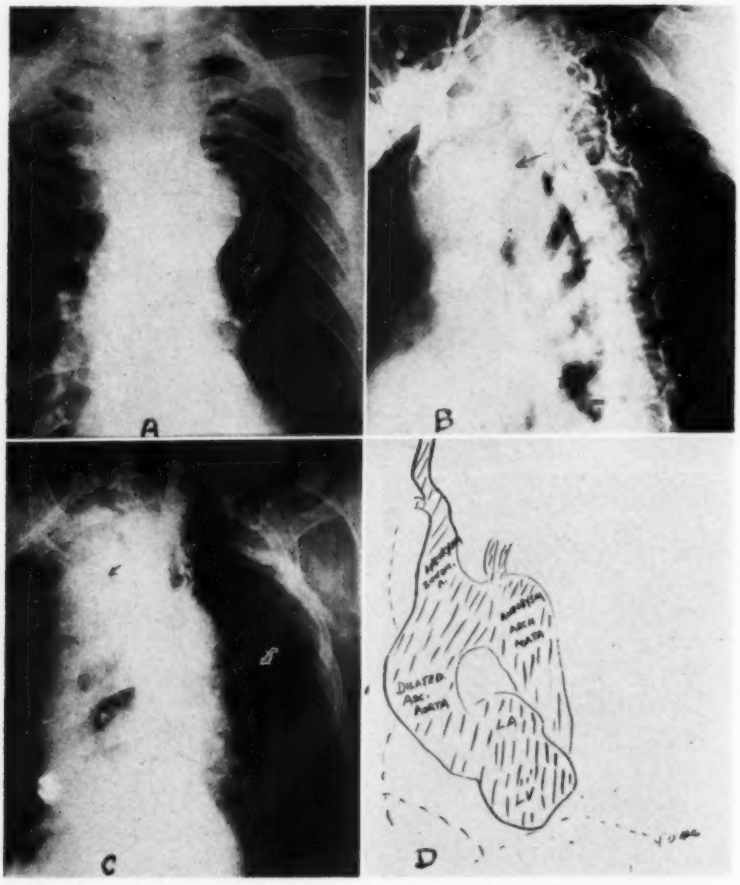

Fig. 2. A. Postero-anterior radiograph of chest showing a right superior mediastinal mass, tortuous aorta, and an aneurysmal dilatation of the aortic arch. B. Angiocardiogram, left anterior oblique projection, with opaque medium injected through right basilic vein, showing obstruction of right innominate vein (arrow) by the superior mediastinal mass. C. Angiocardiogram, left anterior oblique projection, ten seconds after injection of opaque medium through left basilic vein, showing fusiform aneurysm of origin of innominate artery, dilatation of ascending aorta, and fusiform aneurysm of distal aortic arch. D. Diagram of Fig. 2 C.

Fluoroscopic examination of the chest is an essential procedure in establishing the diagnosis of innominate artery aneurysm. This procedure was performed in 16 of the 18 cases in this series. *Pulsations in the mass* synchronous with the aorta were observed in 8 of the 16 cases. The mass

never appeared to change during swallowing, respiration, or the Müller or Valsalva tests. *Barium studies of the esophagus* were made in 13 of 18 cases and revealed no esophageal displacement in 5 cases. The esophagus was displaced by the mass to the left and posteriorly in 6 cases, and to the left only in 2 cases (Fig. 4A). In no case was there displacement to the right, which, when present, is against the diagnosis of innominate aneurysm. This has also been the experience of others (3).

The right leaf of the diaphragm was paralyzed in 1 case from pressure by the innominate aneurysm upon the right phrenic nerve.

Laminagraphic studies were carried out in only 2 patients with innominate aneurysm. This procedure gives better visualization of the mass and its relation to surrounding structures (Fig. 4B) and may reveal faint calcium deposits in the walls of the lesion not otherwise discernible. Slight erosions of the right clavicle and manu-

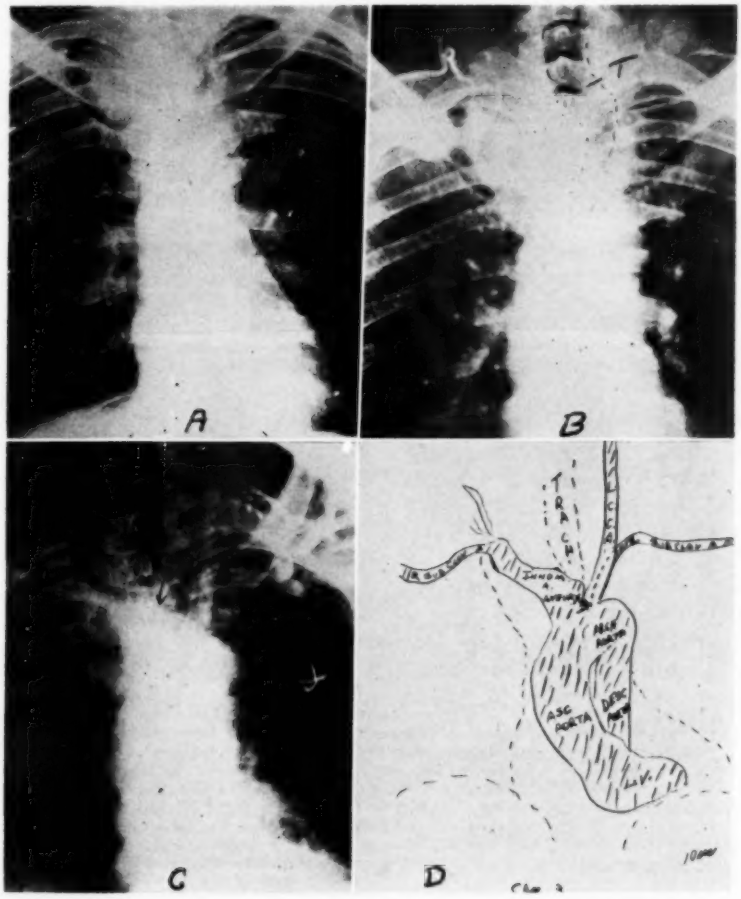

Fig. 3. A. Postero-anterior radiograph of chest showing right superior mediastinal mass. B. Angiocardiogram, anteroposterior projection, with opaque medium injected through right basilic vein, showing compression, displacement, and partial obstruction of right innominate vein. Note trachea (T) displaced to left. C. Angiocardiogram, anteroposterior projection, opaque medium injected through left basilic vein, showing fusiform aneurysm of innominate artery at its origin. The right common carotid artery was not filled, possibly due to thrombosis. Wall of aneurysm is thickened by a laminated thrombus. D. Diagram of Fig. 3 C.

brium may also be revealed by this procedure only, as in 1 case in our series.

Kymographic studies were made in 2 cases of aneurysm of the innominate artery. Pulsations in the mass were visible in only 1 instance. This examination helps to confirm fluoroscopic impressions but it is not too helpful as a diagnostic tool in this condition.

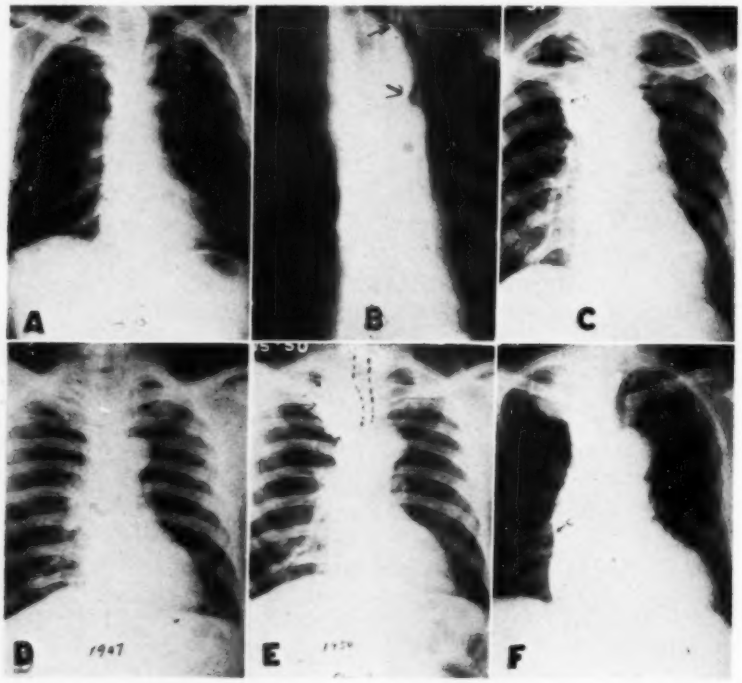

Fig. 4. A. Patient B. P. Postero-anterior radiograph of chest showing right paratracheal mass, displacing esophagus and trachea to left (innominate artery aneurysm). There is also luetic osteitis of the right clavicle (arrow). B. Laminagram of same patient as in Fig. 4A showing tracheal compression by aneurysmal mass.
C. Patient J. O'H. Postero-anterior radiograph of chest showing large innominate artery aneurysm with peripheral calcium deposits (C).
D. Patient W. L. Postero-anterior radiograph of chest of patient taken in 1947 showing no evidence of a mediastinal mass. E. Postero-anterior radiograph of chest of same patient, taken in 1950, showing the development of an innominate artery aneurysm. The trachea (dotted) is now displaced to left.
F. Patient F. W. Postero-anterior radiograph of chest showing calcification in ascending aorta with dilatation, indicative of luetic aortitis, associated with large aneurysm of innominate artery. Trachea (T) and esophagus displaced to left.

ANGIOCARDIOGRAPHIC FINDINGS

Angiocardiography was performed in 7 of the 18 cases of innominate aneurysm. In 1 case the examination was a failure. In another it revealed obstruction of the superior vena cava on injection of medium through the left basilic vein; opacification of the mass was not obtained. The mass was opacified in the remaining 5 cases.

Aneurysms of the innominate artery usually compress and displace the innominate veins. The right innominate vein and superior vena cava may be displaced laterally and occasionally may be actually obstructed. For this reason, injection of the opaque medium through the left basilic vein furnishes the best opportunity for opacification of the mass. In 2 patients this observation was demonstrated (Figs. 2 and 3). The left innominate vein may be displaced downward, anteriorly, and to the left (Fig. 1B and C).

Superior vena cava obstruction was demonstrated angiocardiographically in 55 cases by Roberts, Dotter, and Steinberg (17). In 1 instance this was due to an aneurysm of the innominate artery.

Of the 5 innominate aneuryms showing opacification in our series, 3 were fusiform, involving the origin of the vessel (Figs. 1, 2, 3), and 1 was saccular in type, involving the origin of vessel. These fall into the "combined type" of Rundle's classification. Films on the remaining patient were not available for study. All of these cases showed thickened walls due to the presence of a laminated thrombus, this phenomenon being common in innominate artery aneurysm.

The size of the opacified portion of the aneurysm varied from 3.5 to 5 cm. at the base and from 5 to 9 cm. in length. Roberts, Dotter, and Steinberg (17) set the arbitrary measurement of aneurysmal formation at 2.3 cm., including the laminated thrombus.

The aorta was generally dilated in 3 of the cases showing opacification of the mass.

Retrograde aortography with a polyethylene catheter through a branch of the left subclavian artery was attempted in 1 case, but was unsuccessful. This technic has been widely used, and Helmsworth, McGuire, and Felson (8) published roentgenograms of a case of innominate artery aneurysm demonstrated by this method.

DIFFERENTIAL DIAGNOSIS

Many lesions located in the right paratracheal portion of the superior mediastinum simulate innominate artery aneurysm. These lesions may be divided into vascular and non-vascular groups.

Of the *vascular lesions, aneurysms arising from the aortic arch* most frequently offer difficulty. These aneurysms usually displace the trachea and esophagus to the right and posteriorly. There is one exception to this rule. Aneurysms of the extreme proximal and anterior portion of the aortic arch may displace the trachea and esophagus to the left, as do innominate artery aneurysms (4, 14). Angiocardiography is essential in the diagnosis of aneurysms arising from the proximal aortic arch. Abbott (1) reported a case of *congenital aneurysm of the superior vena cava* which closely simulated an innominate aneurysm. A second case observed recently at the Emory University Hospital was associated with anomalous pulmonary veins, which emptied into the superior vena cava (13). We have also observed a case of a *cavernous hemangioma of the right superior mediastinum* which on routine roentgenograms simulated innominate artery aneurysm, but the correct diagnosis was established by angiocardiographic studies. In arteriosclerotic patients with hypertension *"buckling" of the innominate artery* may simulate innominate aneurysm (9); this lesion can be excluded by angiocardiography.

Of the *non-vascular lesions* located in the right superior mediastinum, neoplasms comprise the largest group. *Mediastinal metastases* (2) from many primary sites may be present as localized right superior mediastinal masses. *Bronchogenic carcinoma* and *lymphomas* have been the most frequent primary sources observed at Lawson VA Hospital. These tumors will usually not show the prominent pulsations, the peripheral calcium deposits, or the aortic changes encountered in most innominate artery aneurysms. As is well known, however, pulsations are occasionally misleading. A vascular mass may not pulsate, and a solid tumor may show transmitted pulsations simulating aneurysm. *Primary neoplasms of the mediastinum* may occasionally (2, 5) simulate an innominate aneurysm. These include thymoma, parathyroid tumors, substernal thyroid tumors (2), neurogenic tumors (3), lipomas, bone tumors of thoracic cage origin (chondrosarcoma, osteogenic sarcoma), and teratomas and dermoid cysts. Kerley has stated that dermoid cysts and ecchinococcus cysts may show transmitted pulsations and peripheral calcium deposits closely resembling aneurysms of the innominate artery (12). Ellis and Good (6) have shown cases of intrathoracic goiter which

have peripheral calcium deposits identical with innominate aneurysm.

Primary tumors of the right upper lobe of the lung may simulate aneurysm of the innominate artery on routine roentgenograms of the chest.

Tuberculomas of the superior mediastinum may be indistinguishable from innominate artery aneurysm except by angiocardiographic studies (19).

Boeck's sarcoid may also produce localized right paratracheal masses in the superior mediastinum (7). This lesion, however, is usually accompanied by hilar nodes and pulmonary infiltrations.

SUMMARY

The clinical and radiologic findings in aneurysm of the innominate artery are reviewed. A study of 18 cases from various Veterans Administration Hospitals is presented.

Aneurysms of the innominate artery comprise about 3 per cent of all aneurysms. Syphilis is almost invariably the etiologic agent. The clinical findings are largely dependent upon the pressure phenomena resulting from expansion of the vascular mass. Pain, pulsatile right anterior cervical mass, dyspnea, hoarseness, cough, dysphagia, venous congestion of face and neck, and pupillary abnormalities are the more commonly encountered clinical features.

Radiographically, a right paratracheal superior mediastinal density is present, which exhibits pulsation in about one-half of the cases. Peripheral calcium deposits are common. The trachea and esophagus are displaced to the left and posteriorly. Esophageal displacement to the right excludes the diagnosis of innominate artery aneurysm. Angiocardiographic findings are diagnostic.

Aneurysm of the innominate artery should be considered in the differential diagnosis of all right superior mediastinal masses.

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Hyperplasia of Brunner's Glands

Report of Two Cases with Review of the Literature[1]

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ARTICLES DEALING with the roentgen diagnosis of diseases of the duodenum contain few references to the duodenal glands of Brunner despite the frequency with which this area is subjected to examination. Golden in 1928 (9) first reported the roentgenologic detection of solitary adenomata and subsequently stated that they are the most common benign tumors of the duodenum (8). Their apparent frequency is further emphasized by the series of other authors (1, 4, 10). The possibility of malignant degeneration of these adenomata has also been considered (1, 12, 14).

Although hyperplasia of Brunner's glands had been described by pathologic anatomists as early as 1876 (13), it was not until 1941 that a comprehensive survey of the pathologic processes common to these structures was published by Robertson (12). On the basis of his descriptions, it is apparent that the gross features of hyperplasia as well as those of adenomata should be demonstrable radiographically. The clinical detection of such lesions was unknown, however, until 1948, when Erb and Johnson (3) reported the case of a 36-year-old male whose chief complaint was mild diarrhea of one year duration. A high gastric acidity and a persistent roentgen demonstration of small opacities confined to the duodenal cap and proximal portion of the descending duodenum were the two impressive preoperative findings. A tentative diagnosis of duodenal polyposis was made. At operation, a cobblestone effect of the duodenal mucosa was found, and pathologic examination revealed the basic lesion to be a hyperplasia of Brunner's glands. Erb and Johnson speculated that the hyperplasia represented a possible protective mechanism against high gastric acidity. This possible relationship was emphasized by the development of a stomal ulcer following extirpation of the duodenal bulb and pylorus with end-to-end anastomosis of the duodenal loop and gastric antrum. A subsequent subtotal gastric resection with removal of the acid-producing portion of the stomach was necessary.

Fig. 1. Case I. Conventional film of stomach in left anterior oblique position. Note ragged appearance of duodenum without compression and thickened gastric rugae. Arrow indicates barium within transverse colon thirty minutes after start of examination indicating marked gastrointestinal hypermotility. It was necessary to administer an additional glass of barium before taking the roentgenograms.

Within the past year we have observed 2 similar cases, one proved by biopsy. In both instances the diagnosis was ini-

[1] Accepted for publication in July 1952.
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tially advanced by roentgen examination on the basis of Erb and Johnson's work. It is the purpose of the present report to summarize these cases and briefly discuss the implications of such a diagnosis.

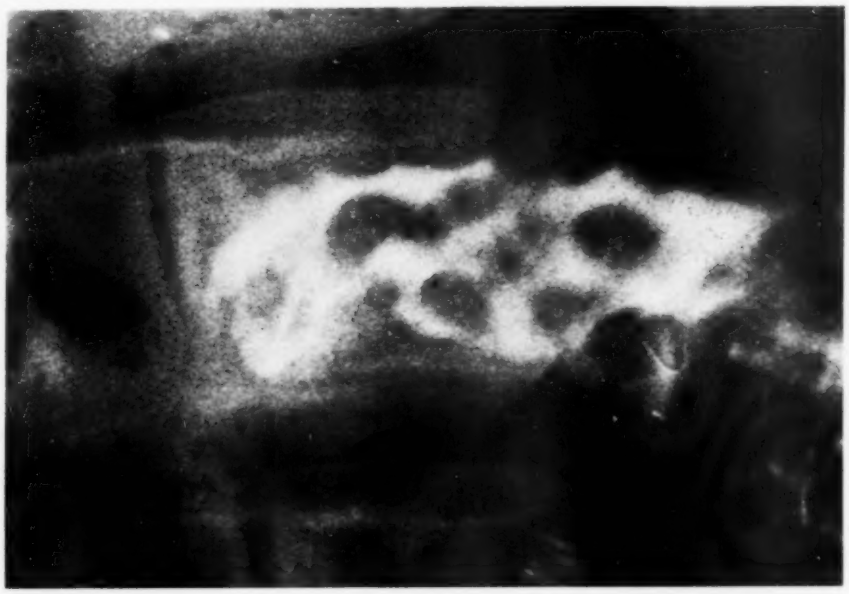

Fig. 2A. Case I. Mucosal relief film of duodenal bulb made at a distance of 36 inches with a Potter-Bucky diaphragm one year before hospitalization. The individual hyperplastic nodules are readily seen.

CASE I: A 35-year-old white Warrant Officer was referred for upper gastrointestinal studies on May 10, 1951, because of intermittent epigastric discomfort of several years duration. This consisted of bloating and belching and an aching sensation extending across the mid-epigastrium. The discomfort usually appeared shortly after meals and was described as "gnawing" in character. Some intolerance to fried foods was noted, with some relief obtained from antacids. Occasionally mild bouts of diarrhea and morning nausea were present, but there was no history of emesis or melena. An upper gastrointestinal series had been performed elsewhere one year previously and was reported as follows: "The stomach is normal in size, shape, and position. Peristalsis is increased. The duodenal cap does not fill satisfactorily and is continually irregular with many large, rounded defects which may be due to a mucosal prominence." No gastric or duodenal ulceration was evident upon a review of the films. (Fig. 2A).

The patient had had a tonsillectomy and appendectomy in 1939, and a subtotal thyroidectomy in 1948. Following the appendectomy in 1939, he was told he had "bowel trouble." He admitted to the use of two to four ounces of alcohol weekly, and a daily average of one and one-half packs of cigarettes. The family history was non-contributory.

Fig. 2B. Case I. Spot-pressure film made at time of admission demonstrating the increased definition obtainable with compression technics. The nodules are not clearly seen within the second portion of the duodenum and the defects overlap due to approximation of the duodenal walls. The apparent differences in size and position of the lesions are due to the compression and distance factors.

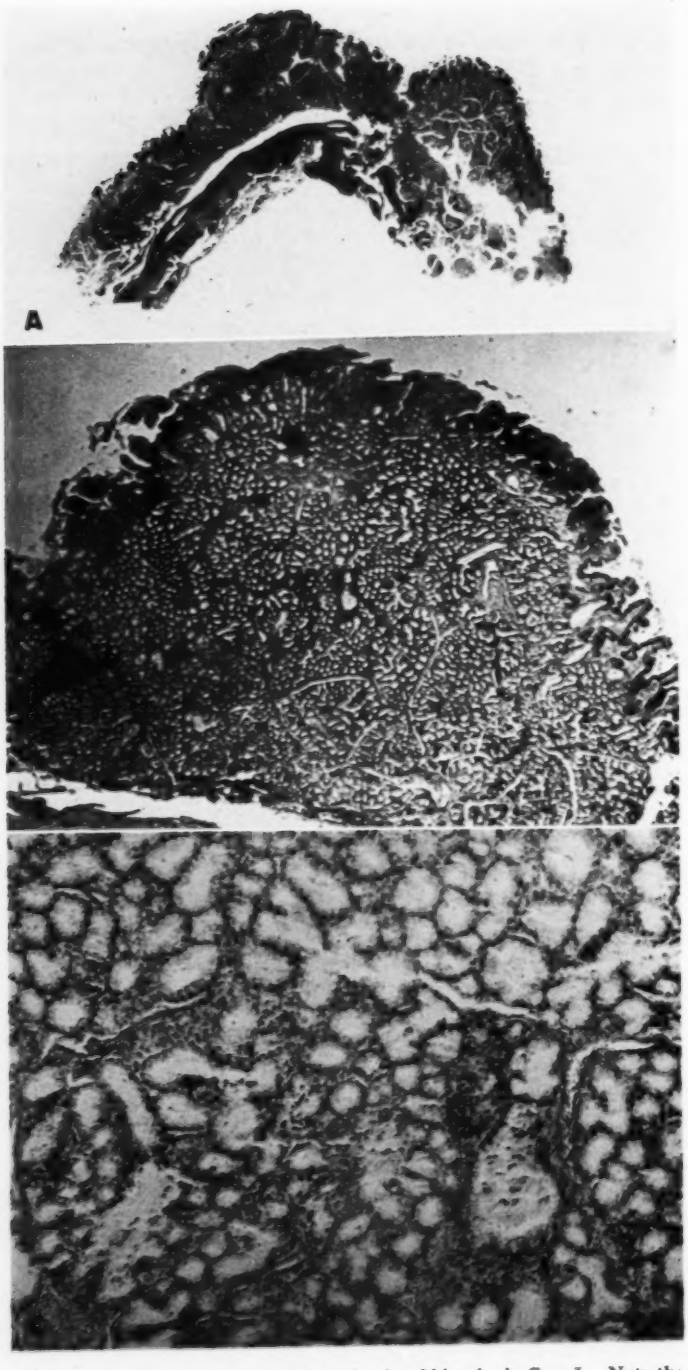

Fig. 3. A. Low power view of the duodenal biopsies in Case I. Note the mound-like thickening just beneath the atrophic mucosa (×35).
B and C. Higher power views of Fig. 3A showing hyperplastic Brunner's glands to be the agents responsible for the nodular thickening of the wall (×85 and ×375 respectively).

Roentgen Examination: Roentgenoscopically the esophagus appeared normal. The stomach showed no evidence of ulceration or neoplasm, but the gastric mucosal folds were moderately thickened and blurred in outline, the overall appearance resembling an "ulcer gastritis." Marked hypermotility was evident, the stomach emptying within thirty minutes and the head of the opaque column reaching the transverse colon during the same period (Fig. 1).

The more specific findings were limited to the duodenal bulb and suprapapillary portion of the descending limb (Figs. 2A and B). Multiple rounded or oval filling defects measuring 0.5 to 2.0 cm. in diameter were present within the bulb. Similar nodularities were imperfectly seen in the proximal descending limb with none apparent distal to the papilla. All of the defects were sessile in nature, but no significant loss of flexibility of the duodenal walls could be demonstrated. Comparison with the previous roentgenograms revealed no appreciable change in the size or distribution of the lesions. A chest film, a barium-enema study, and a cholecystogram were all within normal limits.

Physical Examination: Examination revealed a well developed and well nourished young adult white male in no acute distress. Other than the scars of previous surgical procedures, the only remarkable physical finding was a generalized abdominal tenderness to moderately deep palpation, slightly more pronounced in the epigastrium and left inguinal region.

Laboratory Studies: The admission white blood cell count was 9,300, with a normal differential; the red blood cell count was 5.0 million. Bleeding time, clotting time, prothrombin time, serology, and urinalysis were within normal limits. Stool specimens were negative for occult blood. A gastric analysis showed a mild hyperacidity after histamine, with the highest reading 78 degrees of free hydrochloric acid and 87 degrees of total acid.

Despite the opinion that the multiple duodenal tumefactions represented hyperplasia of Brunner's glands, the fear that they might be true mucosal polyps prompted hospitalization of the patient for further study and exploratory laparotomy.

Operative Findings: Laparotomy was performed on July 17, 1951. The duodenum externally appeared normal, but when opened, a cobblestone pattern of the mucosa was seen. This was due to numerous small nodules which appeared to lie immediately beneath the mucosa and which had a sponge rubber consistency. Smaller nodules were felt distal to the papilla of Vater. No enlarged lymph nodes were encountered.

These findings were felt to coincide with the roentgen interpretation and the condition was considered to be definitely benign in nature. For this reason it was elected to leave the duodenum *in situ* after taking specimens for microscopic study. The acid-producing portion of the stomach was removed in the light of Erb and Johnson's report, and a gastrojejunal Hoffmeister anastomosis was accomplished.

Pathologic Report: Gross: Two fragments of tissue are identifiable as intestinal mucosa with some underlying muscle, the larger measuring 3.0 × 0.7 × 0.5 cm. There is a central, mound-like thickening of the wall of one specimen while the second shows a similar, though double, "humped" appearance (Fig. 3A). This sessile thickening measures 1.0 to 1.5 cm. in diameter at the base and is localized to the mucosa and submucosa. The thickened portions are composed of moderately firm and glistening white tissue. *Microscopic:* There is mild atrophy of the lining epithelium with infiltration by lymphocytes, occasional polymorphonuclear leukocytes and eosinophilic leukocytes, and the stromal capillaries are mildly hyperemic. Beneath this layer, the glands of Brunner account for the prominent nodular thickening (Fig. 3B), the individual acini being increased in size as well as in number, although the latter change is more prominent. The acinar pattern is regular with a few focal hemorrhages and collections of lymphocytes between the glandular lobules (Fig. 3C). The fibrous septa between the glands are somewhat thickened, but the muscularis mucosa and underlying muscularis are not hypertrophied. Encapsulation of the thickened areas and cellular atypism are absent.

Clinical Course: The postoperative period was uneventful. At present, the patient is asymptomatic on a regimen of small frequent feedings.

CASE II: The patient, a 31-year-old airman, was referred for a gastrointestinal series on Nov. 11, 1951, with the complaint of "stomach cramps" two to three days previously. The attack lasted approximately five hours, the most severe pain being experienced in the mid-epigastrium without radiation. The cramps occurred intermittently during this period, with freedom from pain after each cramp. Heartburn and flatulence usually followed the ingestion of whisky, tomatoes, or citrus fruits, but nausea and vomiting were denied. The only other previous complaint referable to the intestinal tract was a similar, though milder, episode in May 1951. Bowel habits were regular, and no tarry stools were noted.

Family history was significant only with respect to the patient's father, who had "intestinal ulcers" necessitating surgical intervention. The patient's only previous illness other than the usual childhood diseases was an attack of appendicitis in 1945 which was treated surgically without complications. He admitted to a "social use" of alcohol and smoked a pack of cigarettes daily.

Several examinations revealed no remarkable physical abnormality.

Laboratory Findings: Routine laboratory data were within normal limits. Gastric analyses, using both 7 per cent alcohol and histamine as stimulants, repeatedly showed elevated free hydrochloric acid

Fig. 4A. Case II. Mucosal relief film of duodenal bulb without application of pressure. Note the lack of clear definition of the hyperplastic nodules. The appearance is suggestive of exaggerated mucosal folds.

averaging 76 degrees. A duodenal drainage was done to determine *p*H values. Base line gastric *p*H's taken immediately before and after the samples were consistently low (1.9 and 1.6), while the hourly duodenal *p*H values were 2.9, 4.6, 6.5, and 5.9, indicating partial neutralization of the acid gastric contents. The low *p*H of the first duodenal specimen was in part probably due to contamination by gastric residuum within the tube.

Roentgen Examination: An upper gastrointestinal series showed prominence of the gastric rugae, hypersecretion, and hypermotility as in Case I. The duodenal filling defects were similar but somewhat larger and tended to overlap, producing less clarity of detail (Figs. 4A and B). In this instance, however, the nodules were readily demonstrable in the suprapapillary region, with one large rounded tumefaction being clearly seen at its junction with the bulb.

Clinical Course: In order to observe the results of therapy on the duodenal lesions, the patient was placed on a regimen of antispasmodics, antacids, and a bland diet. In three weeks, an upper gastrointestinal series revealed the same round duodenal defects observed previously. A repeat gastric analysis showed continued elevation of free hydrochloric acid following both histamine and 7 per cent alcohol as a stimulant. Although this patient was not operated upon, serial roentgenographic studies were carried out over a period of four months, and an identical pattern was reproduced on each occasion.

The patient has been free of symptoms since his initial attack save for occasional heartburn and sour eructations. These are readily controlled by avoiding citrus fruits and carbonated beverages.

DISCUSSION

Initially referred to by Wepfer in 1679, the "duodenal glands" were first completely described by Brunner in 1687 and 1715 (15). Of the ramifying, tubuloalveolar type, they are similar to the pyloric glands of the stomach; they are abun-

Fig. 4B. Case II. Spot-pressure film of bulb which demonstrates the individual tumefactions. Arrow points to one large defect at the junction of the first and second portions.

dant only from the region of the pylorus to the ampulla of Vater. Below this, they diminish in number and volume and finally disappear at the duodenojejunal junction. The glands are located in the mucosa and submucosa. They may vary in size, Brunner dividing them into (*a*) *grande*, (*b*) *moyenne*, and (*c*) *petite*. The largest are found exclusively in the first portion of the duodenum and measure 3–5 mm. in diameter; those in the second group measure about 1 mm. in diameter, while the smallest measure 0.2 to 0.3 mm. and consequently are not visible to the naked eye.

The glands secrete a slightly to highly viscid fluid comparable to egg white and containing a moderate amount of clumped mucus (7). Florey and Harding (6) showed that the passage of hydrochloric acid over the duodenal mucosa produces a marked increase in the amount of secre-

tion, as well as depletion of the mucin content of the glands. At a *p*H of 8.2 to 9.0, neutralization of an approximately equal amount of gastric secretion occurs. These same investigators were able to demonstrate that the duodenum possesses a much greater resistance to ulceration from gastric juice than does either the ileum or jejunum. It was their conclusion that the normal secretion of Brunner's glands protects the mucosa of the duodenum from the damaging effect of acid gastric juice by means of the alkaline mucus. They further suggested that malfunction of Brunner's glands may be responsible for ulceration. Ivy *et al.* (11) concur in this "protective theory."

The duodenum is subject to pathologic changes found in most organs, although to a less frequent degree (excluding ulceration and ampulla of Vater tumors). This holds to an even greater extent when the duodenal glands are considered. Thus, in an excellent summary of the pathology of Brunner's glands, Robertson remarks on their "stability" and "colorlessness," adding that "the glands are marked by an outstanding passivity and a lack of any special or prominent alteration under abnormal conditions."

Feyrter (5) in 1934 reported the results of a study of the duodenum in 2,800 cases. He recognized three types of hyperplasia of Brunner's glands: (1) *diffusely nodular hyperplasia*—coarse mucosal folds and irregularly circumscribed nodules composed of multilobulated masses of duodenal glands which are distributed throughout the greater portion of the duodenum; (2) *circumscribed nodular hyperplasia*—isolated nodules of Brunner's glands located especially in the superior portions of the duodenum and often accompanied by atrophy of the intervening glands; (3) *adenomatous hyperplasia*—single nodules varying from the size of a hazelnut to that of a pea, frequently extending into the duodenal lumen. Robertson concurs with this classification although he uses the term "hypertrophy" for these changes. It would appear that our 2 cases and possibly Erb and Johnson's generally fit into the second group.

The relationship of hyperplasia and true adenomata of Brunner's glands deserves consideration in view of the conflicting opinions regarding the incidence and histologic characteristics of the latter. Various authors list the adenoma as the commonest benign duodenal tumor, and Bockus states that one-half of these possess the structure of Brunner's glands. Robertson, on the other hand, feels that the majority of "so-called adenomata" should properly be regarded as examples of "hypertrophy" and that such structural alterations are not related to any neoplastic process. The two may be confused since duodenal adenomata tend toward a sessile type of growth, a configuration that is characteristic of hyperplasia. In addition, both entities show a microscopic increase in the glandular elements. The hyperplastic nodules, however, do not exhibit encapsulation or a central stalk, and continuity with the surrounding wall structures is maintained.

The incidence of carcinoma arising in Brunner's glands is therefore of significance, particularly since it is estimated that 6.6 per cent of all small bowel adenomata eventually exhibit malignant change. Stewart and Lieber (14), in 1937, in a review of the literature found 104 cases of suprapapillary carcinoma of the duodenum, 35 of which they regarded as acceptable. They admitted the possibility that Brunner's glands were the source of the cancer in 3 cases but considered the evidence as questionable, and concluded that there is no proved instance of carcinoma arising from Brunner's glands. A similar opinion is expressed by Robertson, who found only 1 case with some of the characteristics of "unorganized hyperplasia." Wilensky (16), in a review of the literature, collected 46 cases of tumors of Brunner's glands, all of which were benign. The foregoing suggests that the risk of malignancy is not significant when a clinical diagnosis of hyperplasia of Brunner's glands is considered.

The roentgen characteristics as indicated by our 2 cases consist of multiple, sharply

defined, and sessile filling defects within the duodenal bulb and descending limb. In addition, non-specific gastrointestinal hypermotility and moderate thickening of gastric rugae are observed. Without pressure the duodenal bulb is ragged in outline, suggesting exaggeration of the mucosal folds (Figs. 1 and 4A). The defects are largest and most abundant within the bulb, where a mottled or "swiss cheese" pattern is produced by displacement of the barium. In the second portion of the duodenum, proximal to the papilla, the nodules diminish in size and number, and none are visible in the infrapapillary region. This distribution corresponds to the anatomic descriptions of the glands by Brunner and others (7, 12, 15).

Roentgen evidence of duodenal ulceration, spasm or irritability is lacking, and flexibility of the bulbar walls is not significantly impaired.

The majority of benign intraluminal neoplasms of the duodenum produce a solitary rounded or lobulated defect which may be of considerable size and therefore should not (with the exception of solitary islands of hyperplasia) constitute a differential problem. Multiple radiolucencies may be encountered upon rare occasions with adenomas, hemangiomas, and lipomas (1). Of these, only the first group produce a pattern similar to that of hyperplasia of the duodenal glands. Since the incidence of true adenomata arising from Brunner's glands would seem negligible in the light of Robertson's work, only adenomatous mucosal polyps need be considered in the differential diagnosis. The roentgen demonstration of pedicles, the presence of polyps in other portions of the small bowel, or concomitant gastric polyposis serves to distinguish mucosal polyps. The association of duodenal polyposis with achlorhydria may be utilized as an additional criterion in the absence of or in corroboration of the above findings.

Duodenitis would appear to be the only inflammatory condition capable of simulating hyperplasia of the duodenal glands. According to Robertson, inflammatory changes in these structures *per se* practically never occur. The resemblance stems from gross enlargement of the duodenal mucosal folds. Buckstein believes that the factors responsible for alteration of the gastric relief pattern are also operative in the duodenum, *i.e.*, changes in the hydrodynamics of the submucosal fluid and contraction of the muscularis mucosae. He further states that in the future it is possible that the only acceptable roentgen evidence of duodenitis will be persistent rounded radiolucencies due to "wart-like excrescences" of the mucosa. In this regard it is interesting to note that occasionally illustrations in articles on the roentgen manifestations of duodenitis closely resemble the pattern in our cases. In such instances histologic proof of the diagnosis is usually lacking. It is conceivable that the two conditions could be confused, particularly when changes in the gastric mucosal pattern suggest the probability of similar alterations in the duodenum. However, the following should serve to distinguish duodenitis from the more static glandular changes: The presence of bulbar irritability with or without spastic deformity; inconstancy in the size, shape, and position of the defects; obliteration of the radiolucencies with compression; and regression of roentgen findings under a therapeutic regime. Although determination of the gastric acidity is not particularly helpful, the absence of hyperacidity is against a diagnosis of hyperplasia of the duodenal glands.

SUMMARY AND CONCLUSIONS

Two clinically detected cases of hyperplasia of Brunner's glands are added to the 1 previously reported in the literature.

It is our belief that the diagnosis of hyperplasia of Brunner's glands can be made when gastric hyperacidity is found in the presence of roentgenologically demonstrable multiple duodenal nodules, in a patient with a vague history of abdominal distress conforming to no specific pattern. Since this hyperplasia is thought to be a protective phenomenon against gastric

hyperacidity, surgical resection of the stomach need not be carried out and, more important, the duodenal tumefactions may be accepted as a benign process. It is felt that judicious use of general therapeutic measures to control symptoms and combat hyperacidity is sufficient.

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Pneumatosis Cystoides Intestinalis in an Adult

Preoperative Roentgen Diagnosis[1]

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PNEUMATOSIS cystoides intestinalis is a rare entity characterized by the presence of gas-containing cysts in the wall of the bowel. While over 200 cases have been reported in the world literature, only 56 cases have appeared in the American literature (2, 3, 5–16). Of these 56 cases, 43 have been in children and 13 in adults. In only 3 cases previously recorded in the United States (5, 15) was the diagnosis established roentgenologically prior to surgery or autopsy; 2 of these were in newborn infants and the other in an adult. The case reported below was diagnosed radiographically and confirmed on surgical exploration of the abdomen.

CASE REPORT

A 55-year-old female was admitted to the Surgical Service of Temple University Hospital on March 11, 1952, with the chief complaints of vomiting and abdominal pain. In the year prior to admission she had lost 50 pounds in weight. For some time she had had ulcer-type pain which was relieved by eating. The patient stated that vomitus frequently contained food known to have been eaten two days previously. For a short time before admission she had been able to retain only liquids, vomiting all solid food.

Physical examination showed a well developed and well nourished white woman in no acute distress (the patient had apparently been overweight before onset of symptoms). No significant findings were elicited. The abdomen was soft and pliable without tenderness or evidence of masses.

Roentgenological examination of the upper gastrointestinal tract revealed a tremendously distended stomach with a high degree of pyloric obstruction. Numerous closely packed, round gas shadows varying from a millimeter to a centimeter in diameter were noted throughout the right side of the abdomen (Fig. 1). These seemed to be related to the course of the small bowel but did not have the roentgen appearance of free gas in the bowel lumen. It was felt that their confinement to the right side of the abdomen was due to displacement by the tremendously dilated stomach. So little barium passed through the pylorus that the exact relationship of the gas shadows to the small bowel could not be determined. A barium enema study disclosed no intraluminal defects in the large bowel (Fig. 2). The large bowel occupied a normal position in the abdomen. A roentgen diagnosis of "pneumatosis intestinalis cystoides" was made. It was the opinion roentgenologically that the small bowel and possibly the omentum were involved in this process.

Fig. 1. Roentgenogram two hours after ingestion of barium, showing high degree of pyloric obstruction and numerous air cysts scattered throughout the right side of the abdomen. There is good visualization of these cysts along the course of a bowel loop in the right upper quadrant.

On March 14, 1952, operation was performed by Dr. John Minehart. On opening the abdomen many air cysts were observed in the bowel wall from the jejunum down to the transverse colon. These were felt to be beneath the subserosal plane and possibly in the submucosa. The cysts were freely movable and could be displaced along the bowel wall. There was a large sclerosing ulcer of the pylorus with the stomach dilated to about four times its normal size. A subtotal gastrectomy was performed.

[1] From the Department of Radiology, Temple University School of Medicine and Hospital, Philadelphia, Penna. Accepted for publication in July 1952.

Roentgen studies of the abdomen nineteen days postoperatively revealed no trace of the previously described cystic gas shadows.

Pneumatosis intestinalis, a common condition in hogs, was first observed in human beings at autopsy and later as an accidental finding at surgical exploration of the abdomen. Finney (3) reported one of the first American cases in 1908. He described a case of carcinoma of the pyloric end of the stomach with pneumatosis of the distal ileum and mesentery. Subsequently cases were recorded in this country by Turnure (16), Twyman (17), Sloan (14), Mills (11), and others. The first American case in an infant was presented by Moore in 1929 (12). The subject has been covered much more extensively in Europe. Excellent reviews, with case reports, by MacKenzie (10) and Stiennon (15) have recently appeared in the American literature.

Fig. 2. Roentgenogram after evacuation of barium enema demonstrating numerous air cysts in the right abdomen and pelvis.

PATHOLOGY

Grossly pneumatosis may occur in many areas of the gastrointestinal tract. This condition is rarely seen in the stomach and never in the duodenum. The areas most usually affected are between the beginning of the jejunum and the transverse colon. There may be numerous "skip areas" between involved segments. There may be involvement of the mesentery, gastrohepatic ligament, gallbladder, falciform ligament, and retroperitoneal tissues.

The cysts may be located in any plane in the bowel wall. In adults they tend to locate subserosally. In infants they are usually submucosal.

Chemical examination of the gas in the cysts has revealed it to have generally the same composition as atmospheric air.

Dissection by the gas produces cavities between the muscular layers or beneath the serosa which appear microscopically to be unlined in cases of short duration; fibrosis, "endothelial" lining, and giant-cell reaction may occur later (15).

CLINICAL PICTURE

In adults pneumatosis intestinalis is usually associated with pyloric obstruction secondary to ulcerative disease. Obstructions secondary to carcinoma and adhesive bands have also been found with pneumatosis. In infants and children some type of enteritis is frequently observed, and these patients are usually in very poor physical condition. Ulcerative colitis is commonly found in conjunction with pneumatosis in children.

Symptoms are seldom related to pneumatosis directly, but rather are the result of the associated pathological process. There have been a few instances of bleeding or obstruction attributed to submucosal involvement.

ROENTGEN PICTURE

In the roentgenogram the cystic collections of pneumatosis may be seen anywhere in the abdomen. The most common appearance encountered is that observed in our present case, namely, multiple small cysts scattered along the distribution of the bowel. The gas may be manifest as linear radiolucent stripes along the bowel margin. Double ring shadows have been

reported due to radiolucency of the gas in the bowel wall surrounding that of the lumen when the bowel is seen on end. There may be gas in the retroperitoneal tissues and gas may even dissect into the mediastinum. Gas between the peritoneal and muscular layers of the diaphragm (1, 4, 8) may simulate pneumoperitoneum. The barium enema study may show radiolucent defects when the process encroaches upon the lumen of the bowel.

ETIOLOGY

At the present time the older "tumor" and bacterial theories of origin of pneumatosis intestinalis have been largely discarded. It is now most generally believed that the condition is produced purely by mechanical factors. Gas which is under increased pressure due to obstruction is forced through a mucosal defect into the bowel or stomach wall. From this location it dissects to the region of the bowel, where it is found at surgery or autopsy. Stiennon (15) believes that once the gas traverses the defect in the bowel wall it dissects into the root of the mesentery and thence spreads to the bowel wall through the mesentery. Such a mechanism would explain the invariable lack of duodenal involvement and also the fact that certain areas along the small bowel are skipped. It also explains why the cysts may be found in the mesentery. From its location at the root of the mesentery the gas may gain entrance to the gastrohepatic ligament, gallbladder, falciform ligament and retroperitoneal tissues. It should be pointed out that in all instances the gas is extraperitoneal in location.

Comment: Since clinically pneumatosis intestinalis is ordinarily relatively unimportant in itself, the chief practical value of its recognition as a roentgenologic entity lies in avoiding attaching undue significance to the abnormal gas shadows. The possibility should be kept in mind that this process may be responsible for an appearance simulating pneumoperitoneum in the roentgenogram.

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An Attempt to Localize the Normal Esophagogastric Junction[1]

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CLINICAL PROBLEMS concerning the distal esophagus are largely anatomic (4). Regional anatomy of the esophagogastric junction is gradually proving to be far more complicated than once believed, and, now that surgical technics permit easy access to the segment, it becomes necessary to submit to critical review the comfortable classical understanding of local structures and relationships.

A pressing problem is that of the exact position of the esophagogastric junction. It is of tremendous practical importance to know whether an abnormality observed in this region represents esophageal or gastric disease. In a provocative paper, Barrett (2) pointed out that many reported instances of esophageal ulcer may actually represent gastric ulcer, in stomachs which have been drawn up by unrecognized esophageal shortening. Similarly, it may be that a large proportion of distal "esophageal" adenocarcinomas arise on the gastric side of the esophagogastric junction. As Barrett so convincingly reasons, whatever external appearances seem to be, any portion of the gullet which is lined by gastric mucosa must be considered stomach because it functions as stomach and because it is heir to the ailments which afflict that organ.

Anatomically, the only clear-cut indication of the limits of the distal esophagus is the uneven line marking the abrupt termination of the squamous epithelium. Quantitative changes in the muscularis mucosae and the muscularis propria are not only less striking and far less precipitous, but are also, of course, impossible of clinical demonstration. Unfortunately, for the radiologist in particular, neither the abrupt increase in the digestive tube's diameter at the stomach nor the obliquity of the esophagogastric junctional angle can necessarily be accepted as indications of the actual beginning of the stomach. In autopsy specimens these often appear to be coincident with the zone marking the epithelial change, but the assumption that the same correlation obtains during life is obviously a dangerous one. The fine roentgen-relief studies of Jutras and colleagues (3) on continuity between esophageal and gastric folds suggest that intrinsic local dynamics may from time to time be responsible for significant shiftings of the esophagogastric junction.

METHOD

This study was executed in an effort to localize the esophagogastric epithelial junction roentgenographically. Esophagoscopy was carried out in test subjects who had no demonstrable abnormality of the region, and the epithelial junction was located. A silver brain clip was fastened to the line of junction under 4-diameter telescopic magnification by a technic previously described (5). Appropriate fluoroscopic and film studies were then made. Because the early results were unexpected, suggesting perhaps esophagoscopic misinterpretation of the location of the epithelial junction, in most cases a biopsy was taken of the line first, with immediate fixation of the clip to the biopsy site.

Studies were made of 15 adults, 14 of whom were males. Their ages ranged from nineteen to sixty years. All had normal esophagograms in the course of upper gastrointestinal roentgenography, and in none was abnormality found by esophagoscopy. The discharge diagnosis was duodenal ulcer in 5 instances, chronic cholecystitis in 5, chronic hepatitis in 3, functional gastrointestinal disease in 3.

[1] From the Gastrointestinal Section, Walter Reed Army Hospital, Washington, D. C. Accepted for publication in July 1952.

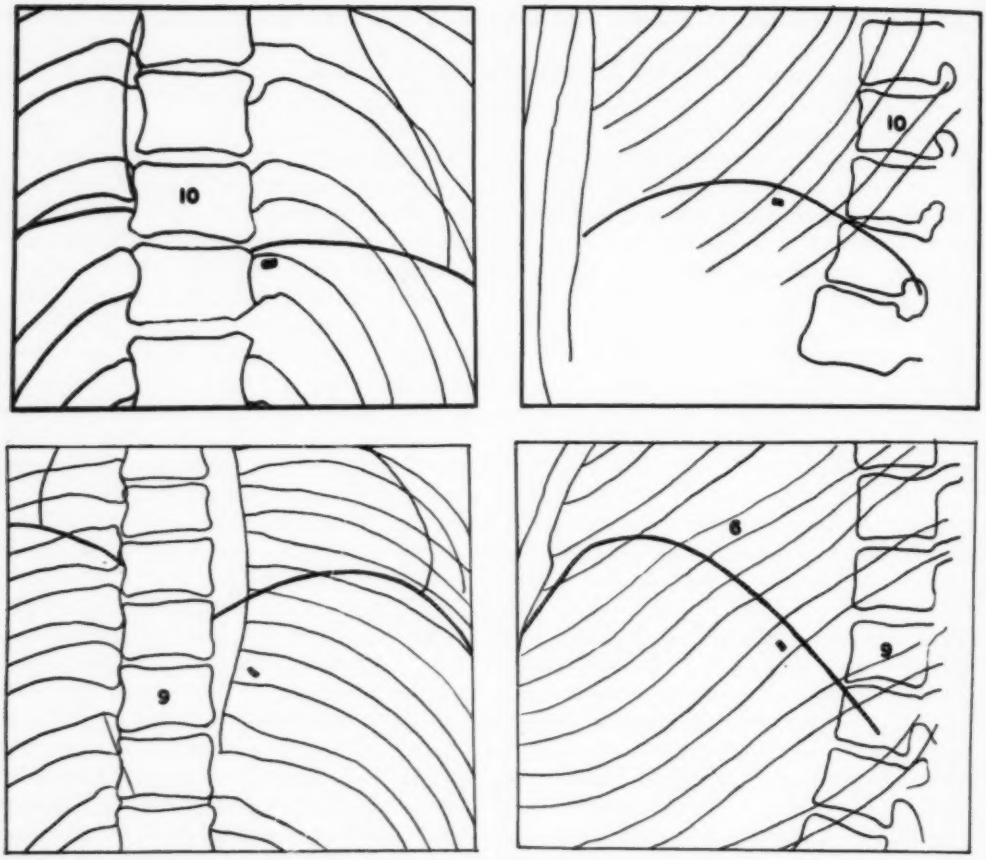

Fig. 1 (above). Position of resting esophagogastric junction, marked by clip, in most hypermorphic patient of study group (height 75 inches, weight 160 lbs., chest girth on inspiration 38 inches). Stomach empty of fluid and air; deep inspiration; direct posterior-anterior and lateral views centered over xiphoid. In the latter view, the profile of only the left diaphragmatic leaf is shown.

Fig. 2 (below). Findings, as described under Fig. 1, in most mesomorphic patient (height 67 inches, weight 178 lbs., chest 43 inches).

RESULTS

To determine variations in the position of the resting esophagogastric junction in relation to the vertebrae and diaphragmatic profile, all patients were studied first in the upright position with stomachs empty of both fluid and air (esophagoscopy carried into the stomach with the patient in the left lateral position regularly causes escape of all roentgen-detectable gastric air). The limits of variation were found in the most hypermorphic and the most mesomorphic subject (Figs. 1 and 2). In all cases the clip lay somewhere between the left border of the spinal column and a point 3 cm. to the left of this, as observed in direct postero-anterior studies. The variations in orad-caudad position when studied during deep inspiration were more marked, the location of the clip varying between a level opposite the lower border of T-8 and the upper border of T-11.

The more important relationship, that of the epithelial esophagogastric junction to the lumen's abrupt dilatation into the stomach proper, was studied in different postures during the terminal stage of deglutition, with small amounts of air or thin barium suspension in the tract. It

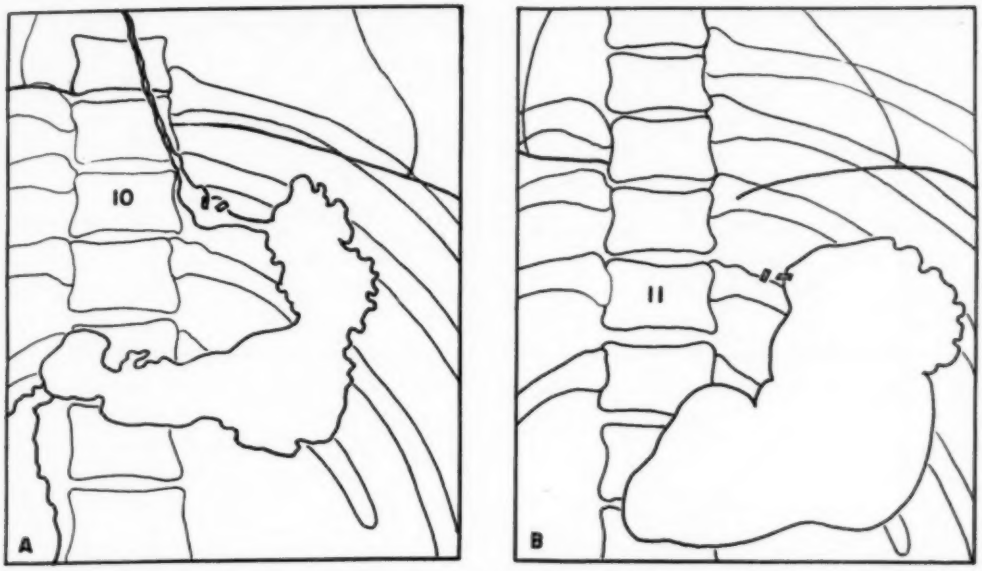

Fig. 3. Direct posterior-anterior views of a 46-year-old man, prone position. A biopsy from the site to which the upper clip was attached showed esophageal mucosa, and a biopsy from the lower clip's site showed gastric mucosa. In A the stomach is largely collapsed, the organs being outlined by a small amount of thin barium suspension; it is apparent that a rather large portion of the gastric cardia is entering into the formation of the distal "esophagus." The next day, the stomach was inflated with approximately 450 ml. of air, B. Then the esophagogastric junction migrated almost into the profile line of the stomach proper.

became apparent that the relation was controlled in part by the volume of the contents of the gastric fundus (Fig. 3). When the stomach was largely empty, containing only enough barium suspension to outline the structures, the gastric mucosa was found to extend as far as 3 cm. up into the "esophagus." When, however, the gastric fundus was distended moderately, the junction was drawn toward the brink of the stomach proper. Examinations in the upright lateral position showed that, as the stomach was progressively inflated, the position of the esophagogastric junction shifted anteriorly no more than a centimeter or two, while the anterior wall of the stomach migrated freely along the inferior surface of the left liver lobe to the anterior abdominal wall (Fig. 4).

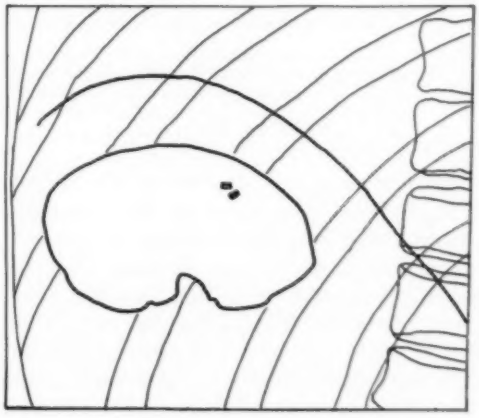

Fig. 4. Patient shown in Fig. 3, with stomach inflated with 450 ml. of air, in upright position, direct lateral view. Gastric distention shifted the position of the esophagogastric junction very little, but the anterior wall migrated almost to the anterior abdominal wall.

The largest part of the information obtained from the study was, of course, gained from fluoroscopic examination, and it was observed from the outset that from time to time mysterious spontaneous migrations of the clips toward and away from the stomach proper occurred (Fig. 5). These excursions extended about 2 cm. in most patients. They could not be correlated with ampullary emptying, the degree of filling of the most distal esophageal segment, respiratory motions, or other

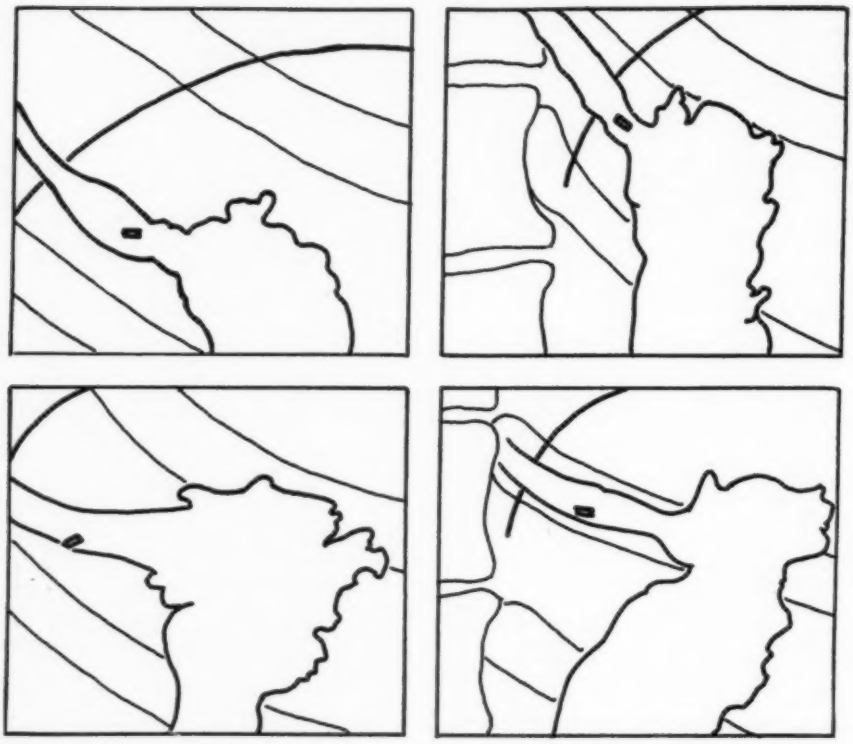

Fig. 5. Serial films taken at intervals of a few moments, supine, without addition of barium, in a 42-year-old man. Biopsy at site of clip included the esophagogastric junction. The excursions of the clip toward and away from the stomach proper proceeded without observable explanation. Note that, in spite of the varying positions of the clip, the terminal esophagus as a whole does not seem to have shortened or lengthened.

evidence that either active or passive longitudinal shortening of all esophageal layers was occurring (Figs. 6 and 7). Fluoroscopically, the appearances were clearly those of a mobile mucosa which was propelling itself over the deeper tissues. In 2 patients a clip was fastened to the esophageal mucosa above the level of the diaphragmatic hiatus, and no such migration was evident; however, the absence of a near-by intrinsic point of reference did not permit precise determination of the matter.

COMMENT

It must be recalled that the esophagus is attached to the diaphragmatic hiatus only by means of the phreno-esophageal membrane, a structure which anatomically promises no more than the most haphazard mechanical fixation. Other connections between esophagus and diaphragm proper, such as those affected by peritoneum and pleura, are less direct and appear to be all but impotent in assuring stability. It is quite true that excursions of the diaphragm cause an alternating straightening and accentuation of the normal esophageal curvatures, but it is apparent that diaphragmatic pressure against the gastric fundus is largely responsible for this. The diaphragmatic hiatus slips up and down around the esophagus to some extent, perhaps encouraged by the normal connective tissue attachments between terminal esophagus and the relatively immobile diaphragmatic crura. The spatial relation of the esophagogastric junction to the hiatus must show continuous variation. The range of this variation cannot easily be measured.

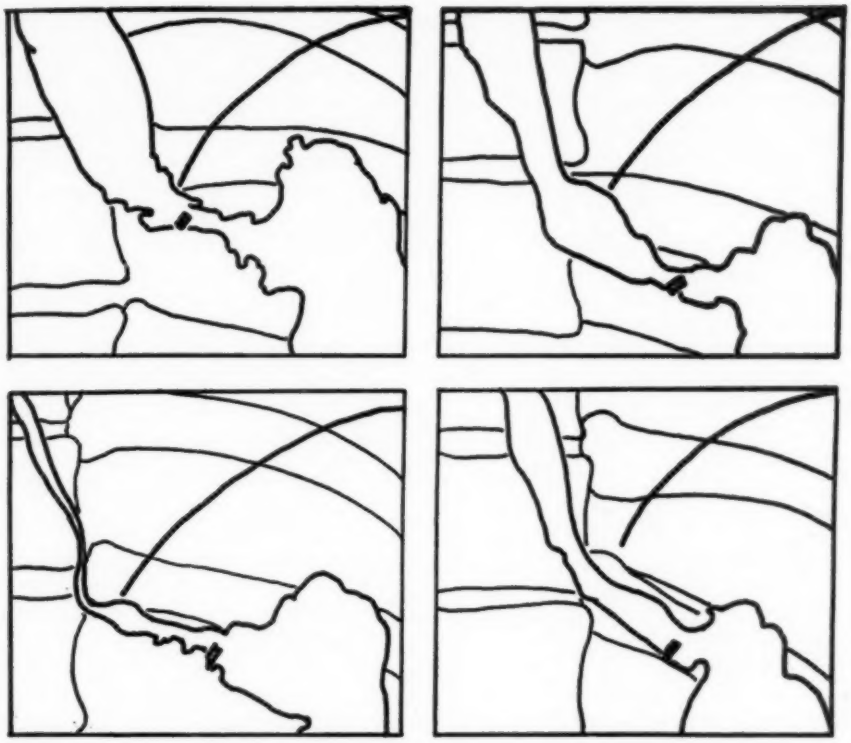

Fig. 6. Twenty-two-year-old man. Biopsy at clip-site included the esophagogastric junction. Spot films during active deglutition. The clip shows a tendency to migrate in relation to the orifice of the stomach proper, without regard to the swallowing phase or the degree of dilatation of the terminal esophageal segment.

The question immediately arises as to whether under certain conditions a degree of transhiatal gastric herniation may not occur in everyone. In spite of a competent diaphragmatic hiatus, it is conceivable that the strain of vomiting and retching may regularly cause a brief orad shift of the cardia or, perhaps, merely a sleeve of gastric mucosa as a transcardial prolapse. One should note in this connection the fluoroscopic observations of Reich (6), recorded during deglutition in an effort to localize the cardia through its functional anatomy. During the terminal phase of deglutition, a portion of the stomach wall was found to reach upward toward the ampulla as a narrow pouch, take the barium suspension from the ampulla, and quickly retreat back into the mural substance of the stomach. This activity was affected to a considerable degree by respiratory motions.

A few endoscopists have been unable to agree with the classical postmortem, adynamic concept of an abdominal esophageal segment. None has been more eloquent than Allison (1), who concluded that in the normal subject, ". . .there is in life no such thing as the abdominal oesophagus. . . no sooner has the instrument [esophagoscope] passed the diaphragmatic pinchcock than the gastric mucosa is seen and acid from the stomach wells upwards." Roentgenologists have been reticent in entering into discussions of the length of the normal abdominal esophagus because of difficulty in precisely localizing the diaphragmatic hiatus.

The answers to these and related anatomic problems must necessarily depend

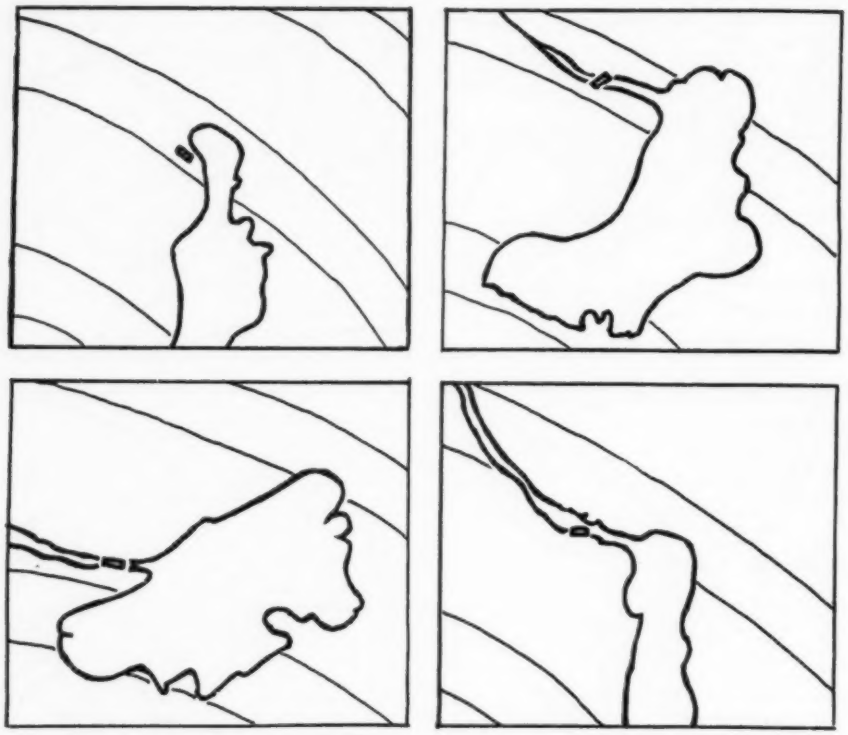

Fig. 7. Thirty-five-year-old man, following a single swallow of barium suspension. Biopsy at clip-site contained only gastric mucosa. In spite of an empty and resting esophagus, the clip shows considerable migration.

on an accurate knowledge of the esophagogastric junction's location, and, to reiterate, no anatomic definition of this junction other than the line of epithelial change is thought to be valid. The line of epithelial junction is in many persons a jagged one, so that, if clips were placed at the tips of the most proximal tongue of gastric mucosa and the most distal tongue of esophageal mucosa, the clips would in some cases be found to lie as much as a centimeter apart. Although at esophagoscopy the point of epithelial change is easily determined for one sector of the organ's lumen, it is very difficult to follow the line consecutively through the entire circumference. In the present study it was not found possible to judge precisely where the clip had been placed in relation to the extremes of the line's uneven course. This is a matter of relative unimportance, but the results must be interpreted with the valid possible variations in mind.

The most important observation concerned the mobility of the mucosa over the deeper layers in the region of the cardia. The absence of explanatory coincident muscular activity elsewhere in the region, either active or passive, makes it necessary to assume that the mucosal migrations were due to contractions of the muscularis mucosae: simple rhythmic shortening and relaxation of the esophageal mucosa drew the gastric mucosa back and forth at brief intervals. Attempts to measure the periodicity of this rhythm were not convincingly successful, but it was observed at fluoroscopy that there could be appreciable shift in one direction in the course of a few moments.

The implications of mucosal mobility and automotion at the cardia may be con-

siderable. There is support here for some of the postulations of Allison and of Barrett. There is also an explanation, apart from whole organ shortening, for the occurrence of certain typical gastric diseases in the distal "esophagus." Some instances of peptic ulceration, adenocarcinoma, erosive gastritis, adenoma and retrograde mucosal prolapse would have to be considered in the light of a sliding mucosa. The occurrence of heterotopic gastric mucosa in the esophagus proper is quite a different matter, of course, and could hardly cause confusion in this connection. This study requires confirmation from other quarters and repetition in instances of distal esophageal disease.

CONCLUSIONS

As a result of roentgenologic studies made upon 15 normal adult subjects following transesophagoscopic attachment of silver brain-clips to the esophagogastric line of epithelial change, it is concluded that a portion of the normal resting "abdominal esophagus" is lined with gastric mucosa and, therefore, must be considered stomach. The location of the normal resting esophagogastric junction varies considerably in its relation to the bony structures, according to general body configuration. The tubular gastric segment which extends up into the "esophagus" may measure as much as 3 cm. in length in the resting state, but it can be obliterated, to become part of the wall of the stomach proper, by distention of the gastric fundus.

Under physiologic conditions, the mucosa of the esophagogastric junction region appears to be mobile over the underlying tissues, and to be capable of considerable automatic migration, presumably through simple longitudinal contraction of its muscularis mucosae.

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Benign Duodenocolic Fistula

Review of the Literature and Case Report[1]

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THE DISCOVERY and management of a benign duodenocolic fistula presented certain features which we believe warrant reporting and emphasizing. This case is summarized along with all other previously reported cases that we were able to find in the literature.

R. S., a 48-year-old unemployed white man, was admitted to Parkland Hospital on Sept. 24, 1951, complaining of lower abdominal pain, chills and fever, diarrhea with dark watery stools eight to twelve times a day, a weight loss of approximately 30 pounds, and progressive weakness. Five weeks before admission, he experienced the onset of epigastric pain which after a few hours became generalized but was worse in the right lower quadrant. He described himself as being acutely ill for the next five days with a temperature as high as 102° F., chills on three alternate days, abdominal distention, and vomiting. As treatment during this period he received only aspirin, local heat to the right lower quadrant of the abdomen, and bed rest. Following the first six days of his illness he began to improve gradually, but diarrhea appeared and persisted until admission, as did the weakness and weight loss. Ten days prior to admission he noticed the onset of night sweats. Six days prior to admission, he had a sudden recurrence of pain, which was relieved by aspirin and a hot water bottle. Following the initial acute period, he noticed that his stools had become darker than previously and he thought at times they were black.

The past history revealed that on Oct. 16, 1950, he had undergone cholecystectomy in another hospital, with an uneventful postoperative course. Between the ages of twenty and thirty he had taken excessively large amounts of alcohol, and in 1924 he was advised to enter a tuberculosis sanitarium, which he did not do.

The patient appeared undernourished and chronically ill, with evidence of recent weight loss. Blood pressure was 110/68, pulse 98, respirations 28, temperature 99.2° F., weight 118 pounds. Physical examination was not remarkable except for mild abdominal tenderness, slightly greater to the right of the umbilicus in the mid-clavicular line. There was a small hernia through a right upper abdominal transverse incision.

Laboratory Findings: Hemoglobin 11.5 gm., red blood count 3.7 million, white blood count 11,233, with a shift to the left. Urinalysis was negative except for 4 plus acetone. Co_2 plasma was 23.1 milliequivalents per liter, Cl 91.8 milliequivalents per liter. Cephalin cholesterol flocculation test was 3 plus in twenty-four hours, and the feces were strongly positive for occult blood on one occasion. The remainder of the laboratory findings were within normal limits.

Roentgen Findings: Because diverticulitis of the colon was suspected clinically, a barium enema study was undertaken. The barium flowed easily to the ascending colon, then suddenly appeared outside the colon, above and below the transverse segment. The identification of barium in the stomach and jejunum was made radiographically (Fig. 1). The fistulous connection subsequently demonstrated was poorly shown. The following day, barium given by mouth passed promptly from the junction of the second and third portions of the duodenum through a short canal into a large cavity in the right lumbar region, thence through another short passage into the cecum (Fig. 2). From these examinations, the radiologic diagnosis of duodenocolic fistula was made.

Operation: Exploration through a right paramedian abdominal incision (Oct. 9) revealed dense fibrous adhesions in the upper abdomen. Only the proximal centimeter of the lateral surface of the appendix could be seen, the remainder lying retrocecally and retroperitoneally. Upon incision of the peritoneum lateral to the cecum and ascending colon and reflection of this part of the colon to the left, the operator entered a space behind the ascending colon lined with granulation tissues. In the middle of this granulation-lined cavity lay the Levin tube which had been introduced into the stomach prior to surgery. Further dissection revealed an opening into the duodenum, at the junction of its second and third portions, through which the tube passed. The duodenum surrounding this opening was soft and only slightly edematous. The opening into the colon was found to be in the cecum at the base of the appendix and on the medial side of the latter. The retroperitoneal portion of the wall of the cecum and lower part of the ascending colon was greatly thickened and much more inflamed than the duodenal wall.

The opening into the duodenum was closed with

[1] From the Departments of Radiology and Surgery of the Southwestern Medical School of the University of Texas and of Parkland Hospital, Dallas, Texas. Accepted for publication in June 1952.

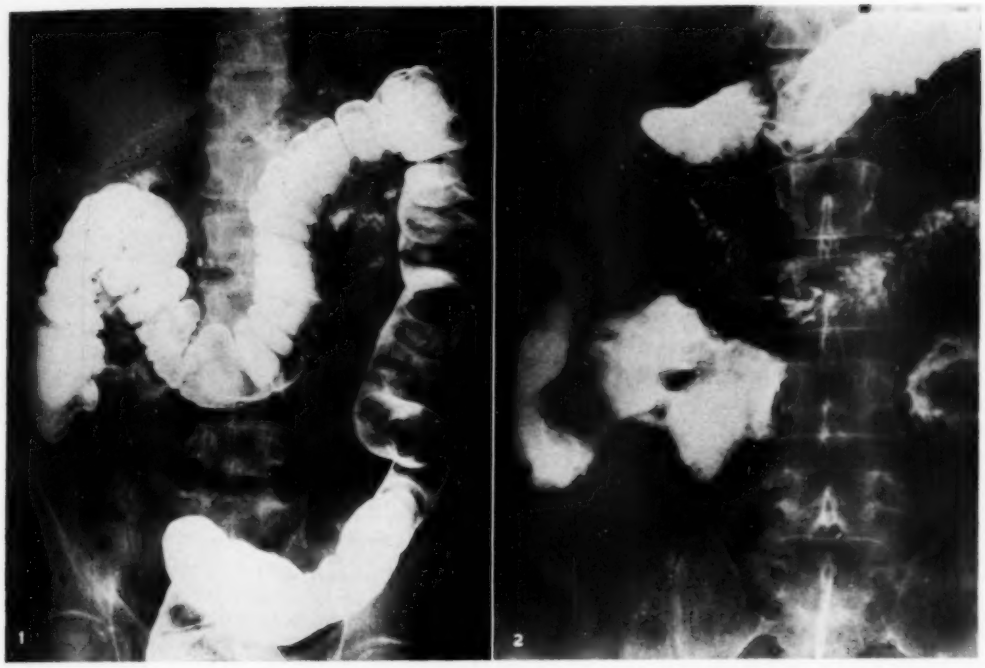

Fig. 1. Barium enema, illustrating sudden appearance of barium in the stomach above the distal portion of the transverse colon, and in the jejunum below the distal portion of the transverse colon.
Fig. 2. Roentgenogram showing barium passing from the duodenum into the large cavity in the right lumbar region and thence through the second short passage into the cecum.

an inner layer of interrupted 00 chromic catgut reinforced with an outer layer of interrupted sutures of 50 cotton. The short thickened appendix was then removed by excising the remainder of its base and the fistulous opening adjoining it. The cecum was closed in the same manner as the duodenum. A rubber sump drain was placed near the suture line in the duodenum, and the suture line in the cecum was exteriorized by suturing it to the anterior parietal peritoneum. Penrose drains were placed in the right gutter and the incision was closed. The patient's immediate postoperative condition was good.

Postoperative Course: Postoperatively the exteriorized suture line in the cecum broke down, with formation of a fecal fistula, which in turn was followed by a wound infection. Both of these responded well to conservative treatment.

Recent Follow-up: This patient was last seen in May 1952, at which time he was asymptomatic and had gained 30 pounds. A barium enema study showed the cecum rather high in the right lumbar region, but there was no evidence of a fistula. Consideration of the operative findings leads us to believe that this fistula was a complication of appendicitis with rupture, although we realize that ruptured duodenal ulcer is a more frequent cause of benign duodenocolic fistula.

REVIEW OF LITERATURE

A search of the literature revealed 14 cases of benign duodenocolic fistula definitely proved and previously reported. Two other cases are recorded but we believe the evidence is not sufficient to include these with the proved cases summarized in Table I. In 1 of these cases, reported by Garland (3), the cholecystographic medium appeared in the colon in fifteen minutes, apparently without passing through the small intestine, but the sinus tract was not demonstrated. The other case, reported by Blondeau (4), was believed to be benign but the patient died without surgical proof of the diagnosis.

Ruptured duodenal ulcer was most commonly reported as the cause of benign duodenocolic fistula. Five cases were a complication of this condition. The next most frequent causes were ulcerative colitis and tuberculous lymphadenitis, 3 each. Ruptured typhoid ulcer and ruptured duodenal

TABLE I: SUMMARY OF PROVED CASES OF BENIGN DUODENOCOLIC FISTULA

Author	Reported Etiology	Previous Abdominal Surgery	Abdominal Pain	Vomiting	Diarrhea	Weight Loss (lb.)	Age	Probable Duration of Fistula	Site of Fistula	Management	Post-operative Course
Rees	Ruptured typhoid ulcer twenty-eight years previously	No	Yes	Yes	No	15	62	9 mo.	2nd portion duodenum to transverse colon	Excision of tract and closure of bowel	Uneventful
McPeak	Ruptured duodenal ulcer	No	No	Yes	Yes	25	52	3 yr.	1st portion duodenum to hepatic flexure	Division of tract and gastrojejunostomy	Uneventful
McPeak	Ruptured duodenal ulcer	No	No	No	Yes	44	46	1 yr.	3rd portion duodenum to transverse colon	Tract excised and bowel closed	Died
Ormandy	Ulcerative colitis	No	Yes	Yes	Yes	100	31	2 mo.	1st portion duodenum to transverse colon	No surgery	Died
McClinton	Ruptured duodenal ulcer	No	No	No	Yes	30	47	2 yr.	2nd portion duodenum to transverse colon	Divided tract and inverted stump	Uneventful
Ogilvie	Tuberculous lymph nodes	No	No	No	Yes	70	52	6 mo.	3rd portion duodenum to ascending colon	Tract divided and bowel closed	Uneventful
Ogilvie	Tuberculous lymph nodes	No	No	Yes	Yes	Yes	54	3 mo.	3rd portion duodenum to ascending colon	Tract divided and bowel closed	Uneventful
Krock	Duodenal diverticulum or ulcer	No	No	Yes	Yes	Yes	68	23 yr.	2nd portion duodenum to hepatic flexure	Tract divided and stump inverted	Uneventful
Railton	Duodenal ulcer	No	Yes	Yes	No	?	45	Several weeks	1st portion duodenum to transverse colon	Devine exclusion	Uneventful
Rife	Penetrating duodenal ulcer	No	No	?	Yes	50	45	4 yr.	2nd portion duodenum to transverse colon	Duodenum closed and terminal ileum to transverse colon resected	Uneventful
Ransom	Ulcerative colitis	Yes	No	No	Yes	Yes	28	?	Duodenum to transverse colon	Subtotal colectomy with closure of duodenum	Uneventful
Ransom	Ulcerative colitis	No	No	No	Yes	Yes	12	?	Duodenum to transverse colon	Subtotal colectomy with closure of duodenum	Uneventful
Winfield	? Tuberculous lymphadenitis	Yes	No	No	Yes	Yes	Adult	?	3rd portion duodenum to sigmoid colon	Excision of tract and closure of bowel	?
Olson	Unknown	Yes	Yes	Yes	Yes	Yes	68	23 yr.	2nd portion duodenum to transverse colon	Divided tract and closed bowel	?
Clayton and Thornton	Ruptured appendix	Yes	Yes	No	Yes	30	48	6 wk.	2nd portion duodenum to cecum at base of appendix	Openings into duodenum and cecum closed and drained	Uneventful

diverticulum were cited as a cause in 1 case each. One case was described as being due to some unknown cause. In so far as history is concerned, 10 of these proved cases had a history of long-standing symptoms and signs of variable character. Four had fistulas preceded by only a relatively acute history, and only 2 of the 14 had previous abdominal surgery. The age at diagnosis varied from twelve to sixty-eight years, with most cases occurring in the fifth, sixth, and seventh decades.

The symptoms of the fistula varied in duration from a few weeks to more than twenty years. The most common symptom was weight loss, complained of by 13 patients. Diarrhea was a symptom in 12 cases and vomiting in 7, in 2 of a fecal nature. Four patients complained of abdominal pain. Surprisingly, only 4 mentioned undigested food being passed with the stools.

DISCUSSION

If all cases are included, those proved, those probably benign fistula, those referred to in discussions (1, 5) and the present case, a total of 19 cases of benign duodenocolic fistula are mentioned in the literature. There probably are others which have not been recorded. For this reason, we feel that this condition should be suspected more frequently and proper investigation undertaken to establish the diagnosis. This condition should be suspected in any patient who presents the above signs and symptoms. Special attention should be paid to those patients having these signs and symptoms, with a history of duodenal ulcer or ulcerative colitis.

Of the roentgenologic procedures, the barium enema study is by far the most successful in demonstrating duodenocolic fistula. This examination was performed in 11 of the proved cases, including our own. The fistula was demonstrated in 7, and barium was shown in the stomach and upper small intestine in 4, giving 11 positive findings out of 11 barium studies. Upper gastrointestinal tract examination revealed evidence of a fistula in only 7 of the 13 cases so studied. We feel, therefore, that barium enema study should be done first in those patients suspected of having a duodenocolic fistula. The problem at fluoroscopy during this procedure lies in distinguishing perforation of the colon into the peritoneal cavity from a fistula. After the diagnosis of duodenocolic fistula has been made roentgenologically, it is necessary to determine whether the underlying process is benign or malignant, and this can be accomplished only by surgical exploration. We are not concerned here with the surgical aspects of malignant duodenocolic fistula. From a review of the surgical procedures which have been employed successfully in the treatment of benign duodenocolic fistula, it is apparent that simple excision and closure of the origins of the fistula is sufficient. If there is any doubt about the integrity of the suture line at the point of duodenal closure, we feel that a sump drain should be placed in that region. The suture line in the cecum in the case reported was exteriorized because the surgeon felt that the suture line might break down on account of the severe degree of inflammatory change in the cecal wall.

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SUMARIO

Fístula Duodenocólica Benigna. Repaso de la Literatura y Presentación de un Caso.

Una pesquisa de la literatura reveló 14 casos de fístula duodenocólica benigna comprobados definitivamente. Preséntase otro caso, en un sujeto de cuarenta y ocho años, en el cual se estableció el diagnóstico roentgenológicamente. A base de los

hallazgos operatorios, parece que la fístula representaba una complicación de una apendicitis con rotura.

En los casos descritos, los síntomas de la fístula variaron en duración de unas pocas semanas a más de veinte años. El síntoma más común fué la pérdida de peso, mencionada por 13 enfermos. La diarrea fué un síntoma en 12 casos y el vómito en 7, en 2 de naturaleza estercorácea. Cuatro enfermos se quejaron de dolor abdominal. Sólo 4 mencionaron la presencia de alimento sin digerir en las heces. Debe sospecharse fístula duodenocólica en todo enfermo que muestre los signos y síntomas enumerados, máxime si hay antecedentes de úlcera duodenal o de colitis ulcerativa.

De los procedimientos roentgenológicos, el estudio con enema de bario es, con mucho, el más eficaz para descubrir la fístula duodenocólica, habiendo sido llevado a cabo en 11 de los casos comprobados, incluso el de los AA. En 7 de ellos, se descubrió la fístula, y en 4 se observó el bario en el estómago y la porción superior del intestino delgado, constituyendo, pues, los éxitos 11 en 11 casos. El examen roentgenológico de la porción superior del aparato gastrointestinal no reveló signos de fístula más que en 7 de los 13 casos estudiados de esa manera, por cuyo motivo debe hacerse antes el estudio con enema de bario en los sujetos en que se sospecha fístula duodenocólica.

The Roentgen Findings in Neuroblastoma[1]

ROBERT S. SHERMAN, M.D., and ROBERT LEAMING, M.D.

A LITTLE OVER ten years ago Wyatt and Farber (1), of Children's Hospital, Boston, published an excellent work dealing with neuroblastoma sympatheticum. The roentgenologic appearances encountered in this tumor were considered in detail, along with its treatment. The writers based their conclusions concerning roentgen diagnosis upon a study of 34 proved cases. No like number of personally observed cases had been presented previously from this point of view nor has any appeared subsequently so far as we know. With the volume of material available at Memorial Center it seemed to us worth while to check their conclusions by an investigation of x-ray diagnosis alone, including the problems of differential diagnosis. The present effort has been limited to a total of 50 cases selected from a somewhat larger number. Of course, not all patients have had a complete x-ray survey of all areas of possible involvement, but the roentgen studies were felt to be generally adequate. Fourteen of the tumors became available at autopsy, and in the rest the diagnosis was proved by pathological examination of tissue provided either by operation or by biopsy.

Peripheral neuroblastoma is a relatively uncommon malignant growth that arises with but few exceptions from the known distribution of the sympathetic nervous system (2). The patient runs a rapidly worsening course marked by metastases to bones, lymph nodes, liver, lungs, meninges, and other organs. Presenting symptoms are commonly abdominal pain, abdominal mass, debility, fever, anorexia and bone pain. Less often symptoms are referable initially to the chest, peripheral nodes, skin, or a single bone. A tumor of the orbit or of the eye itself is not uncommon. We have purposely included several examples of retinoblastoma because in the Pathological Laboratories at Memorial Center it is believed that neuroblastoma and retinoblastoma are essentially similar neoplasms (3). Radiographically they seem to show like changes.

The histologic recognition of neuroblastoma is not always easy and consequently mistakes are occasionally made. Neoplasms said to be confused with neuroblastoma are Ewing's tumor, primary reticulum-cell sarcoma of bone, and rarely even certain osteogenic sarcomas (3). This is an added reason why the roentgenologist should be familiar with the x-ray appearance of this tumor.

GENERAL INFORMATION CONCERNING NEUROBLASTOMA

Age: The essential fact that should be remembered about the age range in neuroblastoma is that the great bulk of the patients are seen from the first few months of life to early childhood. Only a few instances of congenital and of adult occurrence are known. The average age was four years in 61 patients with proved neuroblastoma at Memorial Center (4).

Duration: The mean number of months of survival in 61 patients with neuroblastoma at Memorial Center was about twenty-one, as judged from the onset of the first symptom to the date of death or the date when the patient was last known to be alive (4).

Primary Tumor (Table I): Although most neuroblastomas have their origin within the abdomen, the chest, neck, and eye or orbit are other possible primary sites occasionally involved. In a few cases the primary site remains unknown even though an autopsy has been performed.

[1] From the Department of Diagnostic Roentgenology of Memorial Center, New York, N. Y. Accepted for publication in July 1952.

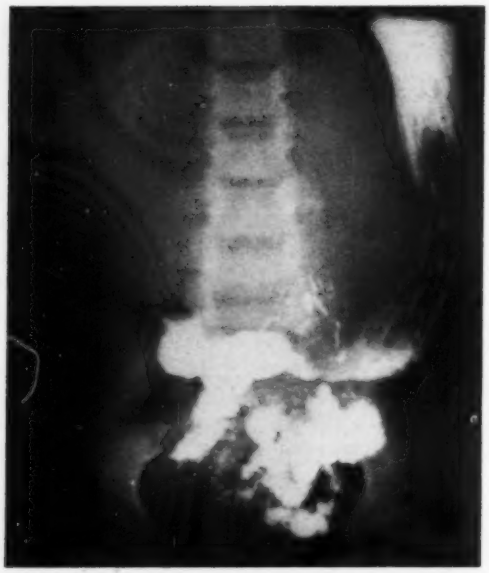

Fig. 1. Abdominal mass with calcification causing displacement of the stomach.

TABLE I: PROVED SITES OF ORIGIN

	Present Series	Wittenborg
Total No. patients	50	73
Abdomen	50%	74%
Pelvis		8%
Chest		7%
Neck	2%	2%
Eye	8%	
Unknown	36%	8%

Incidence of Bone Change: Thirty-seven of the 50 patients (74 per cent) with neuroblastoma on whom our paper is based showed one or more areas of bone metastases. In 26 of the 37 (70 per cent) there was evidence that more than one bone was involved. A solitary bone lesion was the presenting finding in several cases. In the series of 73 proved neuroblastomas from Children's Hospital, Boston, reviewed as to the results of roentgen therapy, there were only 26 patients (35 per cent) with bone metastases on admission (5).

Bones Involved: Table II shows the bones found to be invaded at one time or another during the period of observation. Usually the changes were bilateral. No metastases were detected either in the small bones of the hands and feet or in the epiphyses.

TABLE II: RELATIVE FREQUENCY OF INDIVIDUAL BONE INVOLVEMENT

Femur	26
Humerus	12
Pelvis	11
Skull	11
Tibia	8
Ribs	7
Scapula	6
Radius	6
Spine	6
Ulna	4
Clavicle	4
Fibula	3

Abdominal Involvement: Twenty of the 50 patients (40 per cent) in our series had x-ray evidence of an abdominal tumor or tumors at one time or another during the period of observation (Fig. 1).

Chest Involvement: Roentgenograms of 10 patients (20 per cent) revealed a tumor within the thorax (Fig. 2 A and B). In a few cases the x-ray examination suggested that the primary tumor might have arisen there.

X-RAY APPEARANCE OF NEUROBLASTOMA

Bone Metastases: Generally all the bone lesions in a patient with neuroblastoma were similar in type so that it was possible to base a description, upon a representative focus. Wyatt and Farber also found this to be true. All 37 of our cases having bone metastases showed some degree of medullary bone destruction. In each instance the borders of the lesions were ill defined. The next most common x-ray finding was cortical destruction, which was encountered in 25 of the patients, varying in amount from a tiny area to wide erosion. This change was usually first seen along the medial aspect of the distal metaphysis of the femur or in a similar position in the proximal metaphysis of the humerus. These sites should be particularly scrutinized for signs of early abnormality. Most metastases were symmetrically placed in regard to the bones invaded and consequently most were bilateral (Fig. 3 A, B, C, and D). The diffuse and the fusiform lesions tended to be symmetrical, both as to the location within a bone and as to bilateral position in the skeleton. Twenty-three patients displayed a periosteal reac-

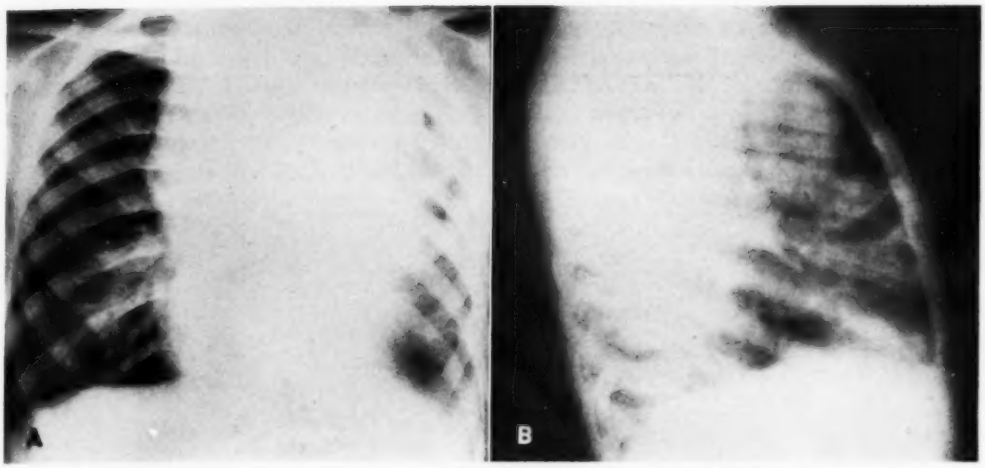

Fig. 2. A and B. Roentgenograms of chest showing mass in posterior mediastinum.

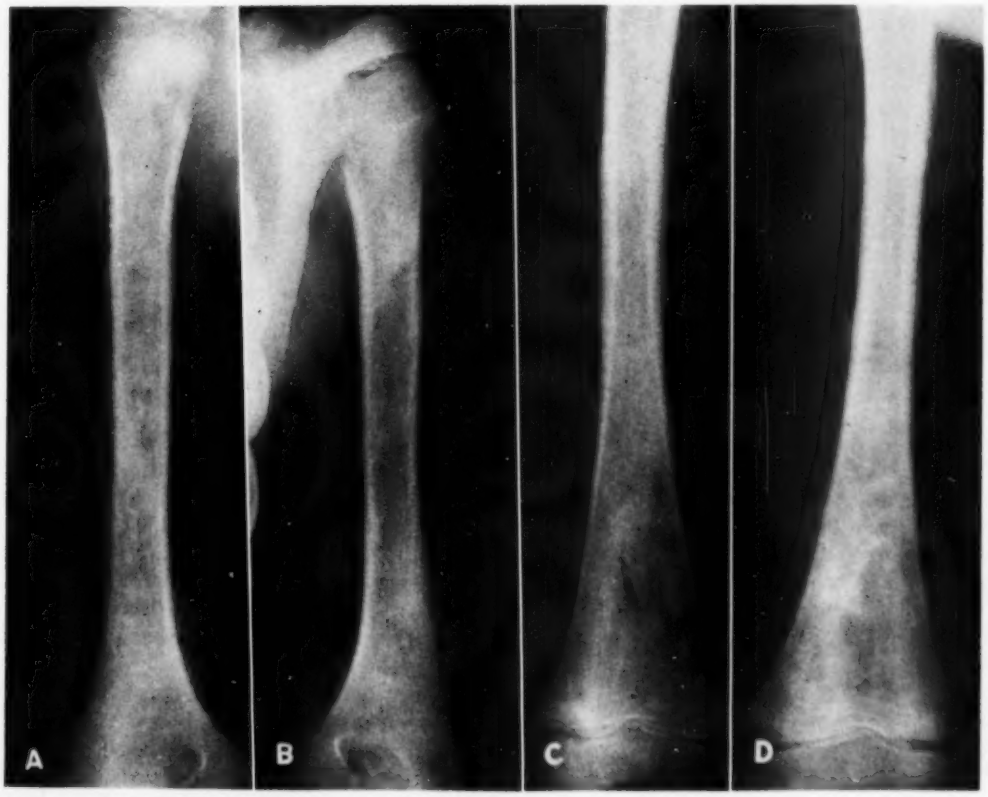

Fig. 3. A, B, C, and D. Diffuse shaft involvement showing symmetry, periosteal reaction, and slight productive changes.

tion. While in 4 of these the reaction was of a perpendicular or sunburst type, in the majority it showed the parallel form. The internal pattern of the bone metastasis was of a fine, patchy character, with diffuse tiny areas of bone loss. This finding was present in 22 cases. The bone involvement was of somewhat oval shape in 21 cases, long fusiform in 8, and diffuse, occupying the entire bone in a general manner, in 2. In 18 cases the metastases were located in the diaphyses, but in 10 there was a tendency for them to lodge in the metaphyses. The sites of involvement were symmetrically placed in respect to the central axis of the bone in 14 cases and asymmetrical in 12. Those with an asymmetrical position within the bone tended to erode and extend along the medial aspect of the shaft. A soft-tissue mass and extension beyond the bone was noted in 10 cases. Ten cases showed some degree of medullary bone production, but there was not a single instance of production occurring alone without destruction. These productive changes were most regularly encountered in the pelvis (Fig. 4). A purely lytic, somewhat circumscribed type of destruction was seen in only 4 instances. There were but 3 fractures, 2 in the spine and 1 in the distal femur (Fig. 5 A, B, and C).

Fig. 4. Roentgenogram of pelvis. Lesions showing some production.

Several points are of value in differential diagnosis. No evidence of a general demineralization of the bones was observed, nor were any epiphyseal changes detected. There were no transverse bands of decreased density at the metaphyses.

In a minority, striking skull changes may occur with separation of sutures, enlargement of the head, perpendicular spiculation, and patchy productive and destructive changes within the bones of the vault. Such findings may develop rapidly— within weeks (Fig. 6). In our experience, when fully developed they constitute a pathognomonic appearance which we regard as specific for the x-ray diagnosis of neuroblastoma (Fig. 7).

Some insight into the rapidity of development of the bone changes was furnished by 5 cases in which there was interval film coverage. Two patients presented normal appearing bones at the first examination, but within twenty-three days in 1 and within two months in the other (Fig. 8, A, B, and C), fairly pronounced involvement was visible. Several additional patients showed an increase of two to three times in the size of bone destruction within a period of two months. Repair of bone lesions following treatment was studied in a few patients. In 1, an area several inches in size returned to normal within three months after x-ray therapy. A few others showed some degree of recalcification and a decrease in size of the lesion after irradiation. Most showed some x-ray evidence of improvement (Fig. 9, A, B, and C).

Fig. 5. A, B, and C. Rate of development of bone involvement. A pathological fracture is present. A. Roentgenogram of femur taken on Aug. 5, 1949. B. Aug. 19, 1949. C. Sept. 19, 1949.

Since the earliest changes in neuroblastoma may be very slight and subtle, the best possible roentgenograms are needed. The diagnosis of early bone involvement is based upon a study of changes of the finest order so that films of exceptional quality taken with the primary object of demonstrating the individual trabeculae are a basic requirement. The finest focal spot and an absence of any motion are essential. It is well to be prepared to compare films of a normal individual with those of the patient (Fig. 10, A and B). In general, we found a considerable degree of consistency in the x-ray appearance of the bone changes. Only a few atypical bone metastases were encountered.

Abdominal Findings: Twenty cases of neuroblastoma showed x-ray evidence of a mass in the abdomen. Nine (45 per cent) of these masses had areas of calcification within them (Fig. 11), varying from a few millimeters to about 4 centimeters in diameter. Often the calcification was sin-

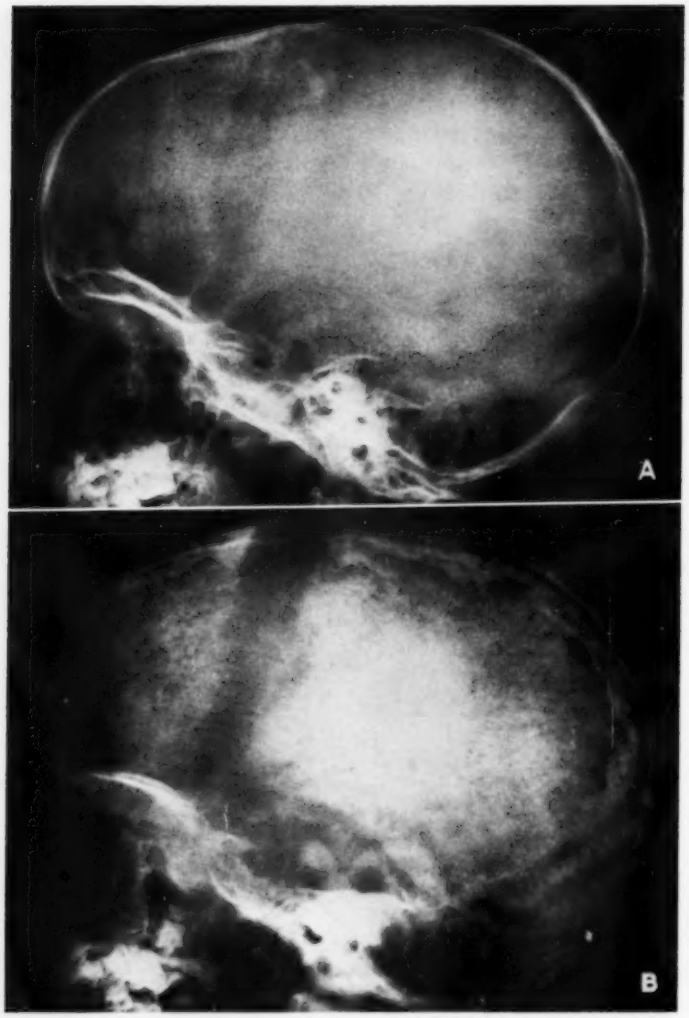

Fig. 6. A and B. Development of characteristic changes of neuroblastoma in the skull. A. Roentgenogram taken March 15, 1951. B. Oct. 17, 1951.

gle, but in a few instances multiple isolated deposits were seen. The calcification was usually very dense and somewhat homogeneous but occasionally showed mottling or fine stippling; it was generally located in the adrenal area. The most frequent single finding was the presence of a mass of water density with ill-defined borders. Since this usually was of adrenal location, it tended to displace the adjacent kidney downward and outward, with the upper pole pushed farther laterally than the lower pole (Fig. 12). At times evidence of extrinsic pressure effect upon the kidney calyces and pelvis was observed. Usually it was sufficiently clear that it was an extrinsic effect that was in operation. The ability to give such an opinion is, of course, directly related to the quality of the roentgenograms, to the thoroughness of the roentgen study, and to the roentgenologist's experience. Incidentally, we feel that insufficient use is made of the lateral abdominal projection (Fig. 13). An enlarged liver shadow was not uncommonly visible. In some cases it was continuous with the

mass in the adrenal area. Sometimes there was a general loss of organ outline with bulging flanks and other evidences of abdominal fluid. Certain solid organs such as the opposite kidney and the spleen were generally normal in appearance. Rarely was there any hydronephrosis and, if present, it was of a mild degree. Evidence of extrinsic pressure on the ureter was seen once or twice. Gastrointestinal series and colon examinations were usually not done. In selected cases one can see that information from such studies might be helpful.

Chest Findings: The primary tumor itself may originate anywhere in the para-

Fig. 7. Well developed, characteristic changes of neuroblastoma in the skull.

Fig. 8. The rate of the involvement is shown. A. Roentgenogram taken May 4, 1951. Normal. B. July 6, 1951. Early changes. C. Oct. 17, 1951. Later findings.

vertebral sympathetic chain and be demonstrable as a soft-tissue mass of water density located posteriorly. The distinct sharp border and the characteristic pressure effects on bones associated with neurogenic tumors of the paravertebral gutter are not to be expected. Neuroblastoma metastases in the thorax may take the form of nodular, indistinctly bordered deposits in the lungs, pleural effusion, nodular pleural thickenings, masses in the mediastinum or the lung roots, in addition to the rib or spine metastases mentioned previously. No calcification was detected in any chest lesion in this series, except in 1 instance where a mediastinal mass represented an extension upward through the diaphragm from the adrenal area. In 1 case in which there was an interval observation over a six weeks period a mediastinal mass grew slightly larger. A good initial response may be seen radiographically after x-ray treatment for the various chest metastases (Fig. 14), but recurrence is often evident in a short period. These points emphasize the rapidity of change in this disease. We doubt if under any circumstances an x-ray diagnosis of neurobiastoma could be made on chest findings alone.

Fig. 9. Effect of irradiation. A. Roentgenogram showing area of disease before irradiation. B. After irradiation. C. Recurrence inferiorly.

Eye Tumors: Properly exposed and positioned roentgenograms of the orbits and facial region may reveal a mass of soft-tissue density. No calcification was detected roentgenographically in such a mass in our studies. No special technics, however, were employed that might show cal-

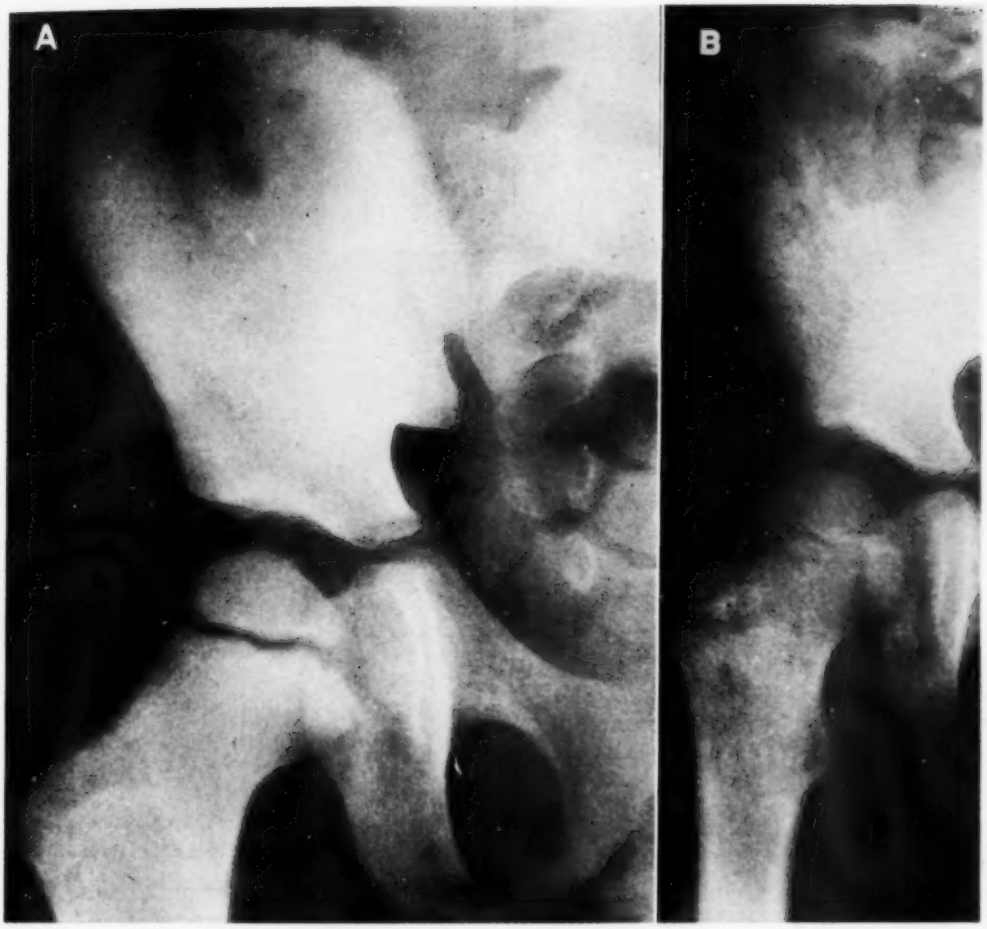

Fig. 10. A. Normal findings in 4-year-old child. B. Roentgenogram showing neuroblastoma in child of same age.

cifications particularly well. The retinal types pathologically are seen to accumulate calcification in foci of necrosis (3). There may or may not be accompanying bone destruction; this we found several times.

DIFFERENTIAL DIAGNOSIS

Roentgenographically, neuroblastoma must be differentiated from Wilms' tumor, leukemia, lymphosarcoma and Hodgkin's disease, primary bone neoplasms such as Ewing's tumor and osteogenic sarcoma, and hydronephrosis, osteomyelitis and rare abdominal tumefactions. A few other conditions under special circumstances might cause confusion.

Since neuroblastomas present often as abdominal lesions, the problem of differentiation from Wilms' tumor arises. The infrequency of bone metastases in Wilms' tumor and the frequency of lung nodules and, most significant of all, the evidence of an intrinsic rather than an extrinsic renal tumor are the important features from a roentgenologic point of view. The bone metastases of Wilms' tumor are purely osteolytic, spherical areas of medullary destruction. Cortical destruction and soft-tissue mass formation are infrequent. The metastases are asymmetrically placed in the skeleton and are usually fewer in number than in neuroblastoma. Therefore,

Fig. 11. Calcification in abdominal mass.

osseous metastases in Wilms' tumor are usually distinguishable from neuroblastoma metastases. Calcification, while it may occur in a Wilms' tumor, is infrequent, and if it is present is generally smaller and perhaps less dense and confluent than in neuroblastoma. A greater incidence of hydronephrosis, ureteral abnormality and evidence of confinement of the disease to the abdomen are additional points favoring a Wilms' tumor. The single most important feature is that the kidney is involved intrinsically. Details of the roentgen differentiation between an intrinsic and extrinsic kidney effect need not be discussed here. Metastases, seen as nodular densities in the lungs or as nodular deposits in the mediastinum or lung roots, are expected in the later stages of this renal neoplasm. Wilms' tumor shows a tendency to become large in the abdomen before spreading to other areas. Very rarely a neuroblastoma may directly invade the kidney and, if there are no other distinguishing features, the roentgenologist may not be able to tell whether the growth is a Wilms' tumor or neuroblastoma. Generally, the one first to recognize the true nature of these two tumors will be the roentgenologist.

These statements regarding the roentgen diagnosis of Wilms' tumors are based on a review of the roentgenograms of 20 proved cases in our x-ray department some years ago.

Several years ago an investigation was also made of the x-ray diagnosis of the bone changes in leukemia, based on 72 proved

Fig. 12. Mass in adrenal area with calcification.

cases with adequate roentgen studies. The abnormal bone changes observed were demineralization, fine patchy bone destruction, periosteal reaction, transverse lines of diminished density at the metaphyses, and very infrequently, slight productive changes. These were usually bilateral and symmetrical. Neuroblastoma does not show the transverse bands of diminished density, general demineralization, or the constant symmetry of skeletal involvement. In the later stages of bone involvement in neuroblastoma and leukemia, it seems to us that there would generally be little difficulty in roentgenologically distinguishing the two diseases. In neuroblastoma there are soft-tissue masses, cortical destruction, and frequent periosteal reaction. In addition, there is usually more or less characteristic evidence of the disease

elsewhere, such as an adrenal mass or skull changes.

Generally speaking, the radiographic differentiation between neuroblastoma and most cases of hydronephrosis should be easy after full x-ray coverage has been obtained. Its basis is the differentiation between an inherent change and an extrinsic effect on the kidney.

In the infrequent case in which neuroblastoma first presents as a single bone lesion, careful search must be made for other foci of the disease (Fig. 15). These will usually be found either in other bones, the abdomen or the chest. Most Ewing's tumors occur in a somewhat higher age range and in our experience have shown a somewhat different x-ray appearance from the rare "solitary" neuroblastomas in bone. Ewing's tumor is usually symmetrically located in the bone, of a fusiform shape, and in the mid-shaft; it shows fine patchy destruction, a parallel form of periosteal reaction, and little or no cortical destruction or soft-tissue mass. While it may metastasize to other bones, usually the additional lesions are few and localized, and they occur late. Ewing's tumor begins and remains as a single bone lesion for a longer time than neuroblastoma before additional areas of disease develop either as nodules in the lung, liver, or other bones. Osteogenic sarcoma, another primary bone tumor likely to be confused with neuroblastoma, tends to have a more or less characteristic x-ray appearance. Metastases to the lungs are frequent, while multiple bone deposits are rare.

The lymphoblastomas, such as Hodgkin's disease and lymphosarcoma, usually occur at an older age than neuroblastoma. In our files the youngest patient with Hodgkin's disease is five years of age and with lymphosarcoma two years (4). In our experience furthermore, lymphosarcoma in childhood involves the skeleton asymmetrically. Its lesions show less cortical destruction, as well as less soft-tissue mass formation and periosteal reaction, than neuroblastoma, and the other more or less characteristic findings of neuroblastoma such as an adrenal mass with calcification and the skull changes are lacking. However, there does remain the occasional case where the roentgenologist may be quite unable to express a worth-while opinion as to whether the disease is a lymphoblastoma or neuroblastoma, in spite of full and thorough roentgen coverage.

Fig. 13. Adrenal mass with calcification, showing kidney displacement.

RECOMMENDED ROUTINE X-RAY STUDIES IN NEUROBLASTOMA AND ALLIED DISEASES

We believe that for those infants or children presenting either a mass in the abdomen, a tumor located in bone, or one or more sites of visible adenopathy, certain basic routine x-ray examinations should be carried out. It would seem worth while to condense such studies into the shortest time possible and preferably to have them made at the first visit to the roentgenologist. For such patients at Memorial Center sagittal and lateral roentgenograms of the chest are advised. If a bone tumor is present, sagittal and lateral

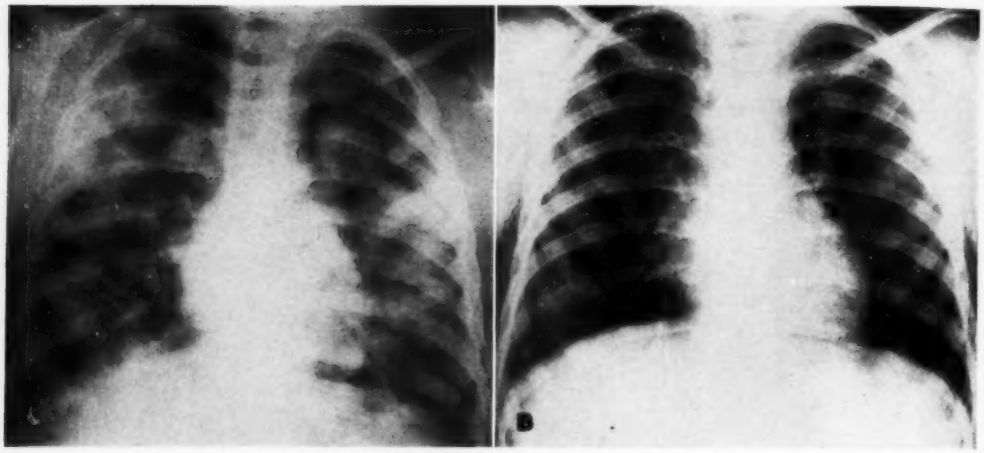

Fig. 14. Roentgenograms of chest. A. May 20, 1932. Metastases in lungs. B. June 27, 1932. Nodules have nearly disappeared after x-ray treatment.

Fig. 15. Presenting lesion was this bulky tumor.

films are made in a manner to show the best bone detail. Then a skeletal survey is needed. Good survey coverage requires roentgenograms of the skull, entire spine, and entire upper and lower extremities. We see no reason why excretory urography cannot be done at the same time. At least one lateral or oblique projection of the abdomen should be included. The roentgenologist can glance at the films before the patient leaves the department, and any special or additional views needed can be taken as indicated.

SUMMARY OF ROENTGEN FINDINGS

A roentgenologist should consider a diagnosis of neuroblastoma if the patient is an infant or young child with x-ray evidence of an abdominal mass, adenopathy, orbital or eye tumor, and bilateral involvement of the bones. If well developed changes are present in the skull, they alone can be considered reliable for a diagnosis. Only slightly less reliable is the presence of a mass in the adrenal area with calcification. Of equal reliability is the presence of bilateral, symmetrically placed areas of bone destruction showing ill-defined borders, cortical destruction, periosteal reaction, a fine, patchy internal pattern, located most often in femora and humeri, soft-tissue mass formation, and a rapid progression of the lesion, with some evidence of response to x-ray treatment. It is upon the detection of one or more of these three features that the roentgenol-

ogist must rest his diagnosis. Since most patients with neuroblastoma present two or all of these features in a more or less well developed fashion, it is our belief that most cases of neuroblastoma are diagnosable with assurance by the roentgenologist.

Wyatt and Farber concluded that there is no characteristic roentgen picture of the primary neuroblastoma. We believe this to be true except in those circumstances when the roentgenologist can reliably identify the presence of a mass in the adrenal region with calcification, and this could be done in about 10 per cent of our cases. Wyatt and Farber also state that when bilateral symmetrical metastases to bone are present, a tentative diagnosis of neuroblastoma can be made in most instances. Our findings substantiate this opinion. We feel furthermore that when the roentgen features of the bone metastases are determined minutely, even greater dependence can be placed upon them; when fully developed we regard them as quite specific. In addition to these points made by Wyatt and Farber, we wish to emphasize the specificity of the skull changes and the fact that most neuroblastomas will show a combination of many, if not all, of these and other important roentgen findings at one and the same time. In our experience most cases of neuroblastoma can be diagnosed without hesitation by the roentgenologist if the roentgenograms are of good quality and if the coverage has been sufficiently thorough.

SUMMARY AND CONCLUSIONS

1. Fifty histologically proved cases of peripheral neuroblastomas with adequate roentgen film coverage have been studied from the standpoint of the x-ray diagnosis.

2. The earlier findings of Wyatt and Farber pertaining to roentgen diagnosis have been substantiated and extended.

3. Most neuroblastomas are diagnosable by the roentgenologist.

4. Certain roentgen findings or combinations of findings are specific for neuroblastoma.

5. The need for complete body x-ray studies in infants and children presenting a solid tumor is reaffirmed.

6. The differential diagnosis of neuroblastoma has been considered from the roentgenologist's point of view.

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The Nutcracker Fracture of the Cuboid by Indirect Violence[1]

M. B. HERMEL, M.D., and J. GERSHON-COHEN, M.D.

COMPRESSION fracture of the cuboid by indirect violence is not mentioned in many textbooks (3, 5, 6, 9, 10, 11) and is seldom referred to in the voluminous literature of the past two decades (7). An isolated reference to cuboidal fracture appears in a single sentence by Schinz, Baensch, Friedl, and Uehlinger (8). Cases were reported by Benassi (1) in 1940, and by Bianchi (2) in 1931. The 5 cases which we are presenting were observed by us during the past year, possibly because these fractures are more common than is generally realized.

CASE REPORTS

CASE I: A 45-year-old woman caught the tip of her left shoe on the edge of the curb while stepping up from the street. Her entire weight was brought to bear upon her foot, which was forced into marked plantar flexion. Sudden severe pain was felt in the tarsal region, and the patient could not step on the injured foot. Within a few minutes she was seen by an orthopedic surgeon, Dr. D. T. Jones, who noted marked swelling over the dorsum of the tarsus and marked tenderness over the midtarsal area both laterally and medially.

X-ray examination revealed a comminuted, impacted fracture of the cuboid, with widening of the calcaneocuboid joint. In addition, an avulsion fracture of the tuberosity of the navicular was found with slight distraction of a crescentic bony fragment (Fig. 1).

Because the cuboid was severely comminuted, a midtarsal fusion was done. After ten weeks there was good bony ankylosis of the joint. The patient then began walking and she has had no residual difficulty or disability.

CASE II: A 48-year-old housewife caught the toe of her right shoe on the edge of a stair step. Her right foot was forced into excessive plantar flexion. Sudden sharp pain was felt in the tarsal area, and she was unable to step on her right foot. Examination showed marked swelling about the dorsum of the tarsus and sharp tenderness over the cuboid and navicular.

X-ray examination of the right foot disclosed a

Fig. 1. Case I. Internal oblique view of left tarsus showing nutcracker fracture of cuboid with widened calcaneocuboid joint. Avulsion fracture of tuberosity of navicular also is present.

severely comminuted fracture of the cuboid with widening and disruption of the calcaneocuboid joint (Fig. 2). An associated avulsion fracture of the tuberosity of the navicular was also present.

These fractures were treated conservatively by immobilization in a plaster cast. The cast was removed after ten weeks, when weight-bearing was begun. The patient still had a painful foot with edema over the dorsum of the tarsal area twenty-four weeks after the conclusion of treatment, but after ten more weeks, all symptoms and signs had disappeared.

CASE III: A 39-year-old woman put her right foot on the gas pedal instead of on the brake in an attempt to avoid a collision while driving her automobile. When she crashed into a wall, her foot jammed against the floor board, with her toes locked against the foot-dashboard. The weight of her body was transmitted through the foot held in plantar [illegible]tion.

The cuboid sustained a fracture as it was compressed between the calcaneus and the bases of the fourth and fifth metatarsals; at the same time, an

[1] From the Albert Einstein Medical Center (Northern Division), Philadelphia, Penna. Accepted for publication in June 1952.

Fig. 2. Case II. Internal oblique view showing crush fracture of cuboid with an avulsion fracture of the tuberosity of the navicular. Note marked similarity to Case I.

avulsion fracture occurred from the medial aspect of the navicular, which was dislocated (Fig. 3).

These fractures were treated by Dr. James S. Knowles of Millville, N. J., and a good result was obtained by conservative immobilization.

CASE IV: A 12-year-old boy, while playing in a freight yard, jumped from a box-car into a gondola, a distance of 10 to 12 feet. He landed in such a way that "his feet went under him." He experienced immediate severe pain in both feet and was unable to walk.

X-ray examination of the right foot showed a crush-type fracture of the cuboid, lateral subluxation of the talus, and a fractured navicular with some downward displacement of the talar head. The left foot showed fractures of the cuboid and of the lateral hook of the navicular with ventral and lateral displacement of the talar head (Fig. 4).

CASE V: A 37-year-old man had caught his toes in the edge of a base in a ball game played eighteen years ago. A compression fracture of the cuboid was treated conservatively by immobilization in a cast for ten weeks. An x-ray examination was recently made for a new injury to the proximal phalanx of his middle toe, when the old fracture of the cuboid was observed and re-studied (Fig. 5).

Fig. 3. Case III. Lateral view of the right tarsus showing comminuted fracture of the cuboid and associated crushing of the lateral and inferior portion of the navicular. The latter has been subluxated dorsally and medially.

DISCUSSION

Avulsion flake fractures of the cuboid are

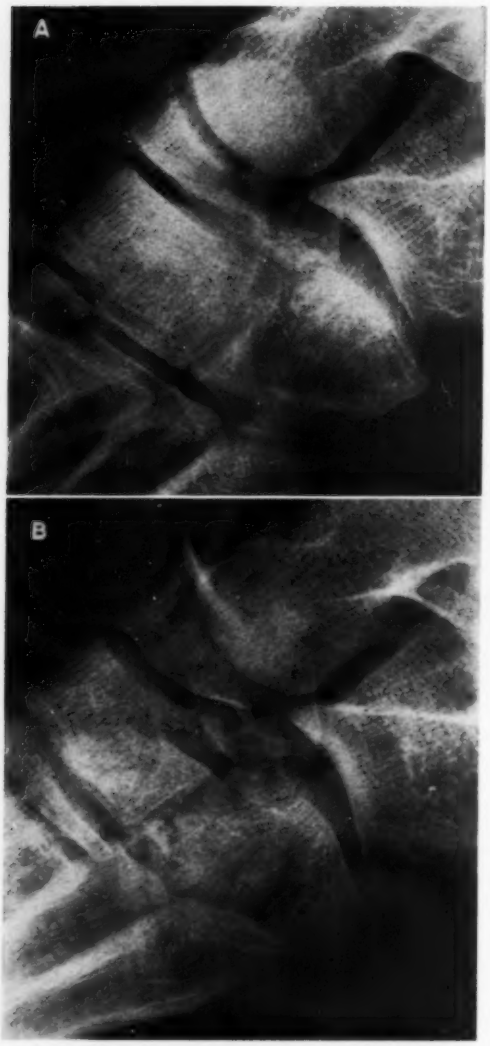

Fig. 4. Case IV. A. Lateral view of right fractured cuboid and inferolateral portion of navicular with medial subluxation of foot at midtarsal (Chopart's) joint. B. Detail film of left tarsus revealing fracture-dislocation as in the right foot, but of greater severity. The mechanism of injury was exactly the same.

of common occurrence in association with tears of the calcaneocuboid ligament and the other capsuloligamentous structures attached to this bone; next in frequency are the crush fractures produced by a strong force applied *directly* to the cuboid, but fractures of the cuboid other than those produced by direct trauma have been reported infrequently.

Benassi (1) describes an unusual isolated superiosteal traction fracture at the base of the tuberosity of the cuboid without appreciable diastasis. He thinks that the mechanism of fracture in this case was the pull of the strong inferior calcaneocuboid ligament due to forced adduction and medial rotation of the cuboid with reference to the calcaneus. In his discussion of cuboid fractures, Benassi claims that an indirect compression fracture between the metatarsals and calcaneus is not possible, since the force is transmitted with diminished violence to the cuboid and the final shock is borne by the tip of the foot on the ground, which is supported chiefly by the medial bones. Our 5 cases would indicate that this conception is incorrect. In each of our cases, the cuboid was caught like a nut in a nutcracker between the bases of the fourth and fifth metatarsals and the calcaneus. In each instance the toes were fixed, the weight of the body being transmitted by the calcaneus through the cuboid and the two lateral metatarsals. The cuboid was then crushed, giving rise to an impacted, comminuted fracture.

This mechanism of fracture is understandable in the light of the anatomy and physiology of the foot. The inner and outer sides of the foot differ in form, structure and function.

Frederick Wood Jones (4), corroborating the earlier observations of others, states that the human foot is designed with an outer part functionally specialized as a static, stabilized, supporting organ and an inner part designed as an elastic, mobile, dynamic organ of propulsion. He calls attention to the fact that the medial longitudinal arch consists of several elements which articulate by curved surfaces, making for elasticity by virtue of its ability to give and bend with varying stresses and strains. This anatomical structure explains the resilience and elasticity of the medial aspect of the foot (Figs. 6 and 7). The longitudinal arch becomes less conspicuous toward the outer border of the foot, where a static rigid relationship obtains. The medial portion of the foot can

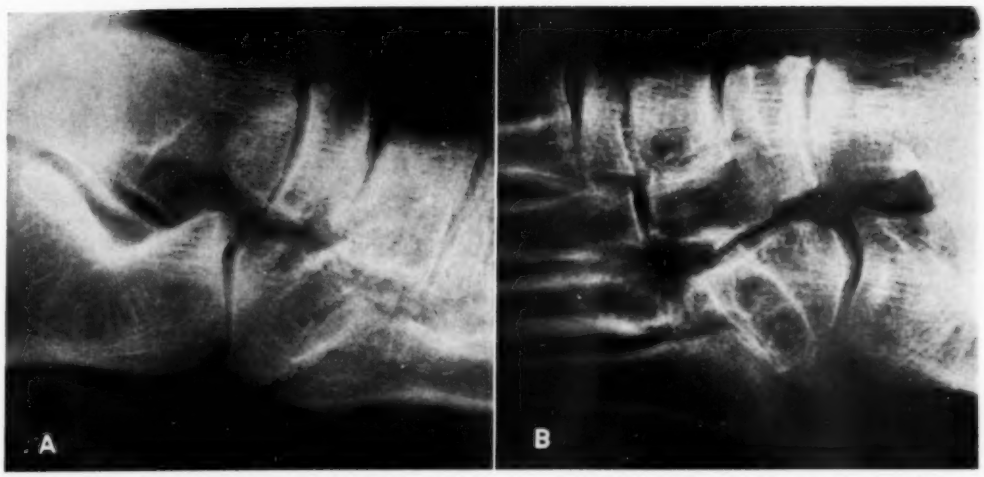

Fig. 5. Case V. A and B. Lateral and internal oblique views of foot showing healed fracture of cuboid with residual irregularity of joints between fourth and fifth metatarsals and the cuboid. Patient has no symptoms with reference to this area.

be likened to the reed which bends with the wind, the lateral portion to the rigid oak that breaks before the force of the wind.

In Cases I and II, the cuboid fractures were accompanied by avulsion fracture of the tuberosity of the navicular, which presumably is due to excessive strain on the tendinous insertion of the tibialis posterior. In Cases III and IV, portions of the navicular also were crushed and the midtarsal joints (Chopart's) were subluxated. In all likelihood the force involved was greater than in Cases I and II. In the first 2 cases, the patients tripped without the sudden deceleration of the body which occurred in Cases III and IV. The fifth patient likewise sustained a relatively mild injury for this type of fracture, and probably did not damage the navicular. A linear fracture in the tuberosity of the navicular could have healed without any visible residuum.

Since little has been written about these fractures, little has been said about the best type of therapy. Case V was treated conservatively and a good result was evident after an interval of eighteen years. Case I was treated by fusion of the midtarsal joint. This patient also had a good therapeutic result, and she now walks without a limp or discomfort. Case II was treated conservatively, also with good results. For severe fractures associated with subluxation or dislocation, as occurred in Cases III and IV, early surgery with midtarsal fusion might decrease the period of morbidity and allow the best functional result. In some cases with severe crushing of the cuboid and disruption of the tarsometatarsal joints (Lisfranc's), fusion of these joints may be necessary. This should not give rise to an appreciable disturbance in gait, since the lateral aspect of the foot is primarily rigid and static.

Fig. 6. Diagram of the longitudinal arch of the foot showing the articulation of the constituent bones by curved surfaces. (Figs. 6 and 7 are reproduced with the kind permission of the publishers of Jones, F. W.: Structure and Function as Seen in the Foot. Baltimore, Williams & Wilkins, 1st ed., 1944, p. 253).

SUMMARY

Five cases are reported of compression

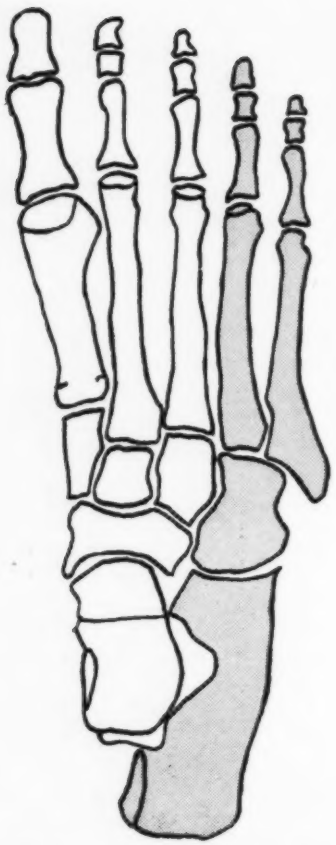

Fig. 7. The functional divisions of the foot, after the diagram of Lambrinudi (p. 246 in text by Jones, F. W. See note Fig. 6).

fracture of the cuboid caused by indirect violence. This fracture has been mentioned rarely in the literature or in textbooks. The nutcracker compression of the cuboid between the bases of the fourth and fifth metatarsals and the calcaneus results when the anterior foot is wedged or fixed in position while the weight of the body is transmitted through the foot held in exaggerated plantar flexion. The anatomical and physiologic basis for this type of fracture is discussed.

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Tarsal Coalition, with Special Reference to Roentgenographic Interpretation[1]

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THE TERM "tarsal coalition" implies a fusion or union of two or more tarsal bones. It is not a rare entity, although a review of the literature might lead one to think this to be the case. The association of this lesion with painful flatfeet and more specifically "rigid flatfoot" makes the roentgenologic diagnosis important. The present paper is devoted to a discussion of coalition involving the calcaneonavicular and the talocalcaneal joints.

REVIEW OF THE LITERATURE

Tarsal fusion has long been recognized by anatomists. In 1880, Lagenbech (1) mentioned fusion of the calcaneal and navicular bones. Harris and Beath (2) described a specimen, prepared by John Hunter in 1885, showing bilateral fusion of the talus and calcaneus. Orthopedists have also been aware of tarsal coalition for some time. In 1921, Slomann (3) presented the x-ray findings in several cases of calcaneonavicular fusion. His cases included that of a 13-year-old boy with a six months history of pain in the left foot on walking. Another case was that of a 17-year-old girl with a history of pain in both feet on walking since the age of ten. Both of these patients had fusion of the calcaneus and navicular.

In 1948, Harris and Beath (4) reported an incidence of 2 per cent of peroneal spastic flatfoot in the routine physical examination of 3,600 Canadians presenting themselves for army enlistment. This was a third of that for flexible flatfoot. These authors contend that the term "peroneal spastic flatfoot" has become a diagnostic "wastebasket" since painful flatfoot is frequently associated with peroneal pain and muscle spasm. Many orthopedists now agree that peroneal muscle spasm is secondary and not the primary cause of this condition. Badgley (16), Harris and Beath (4), and Coventry (6) believe that "rigid flatfoot" is more frequently due to tarsal anomalies, and they reserve the term tarsal coalition for this entity. It is pointed out that peroneal spasm is associated with inflammatory lesions of the tarsal bones, such as rheumatoid arthritis, with development of a valgus deformity of the feet secondary to peroneal spasm. These authors therefore advocate discarding the term "peroneal spastic flatfoot" for one specifically describing the pathologic changes.

ETIOLOGY

Tarsal coalition is thought to be a congenital anomaly.

The term "calcaneonavicular bar," by usage, includes bony, fibrous, and cartilaginous types of union. These types of union are also implied in the term "talocalcaneal bridge."

Coalition of the calcaneonavicular type may be related to the calcaneus secundarius, a rare sesamoid, occurring between the calcaneus and navicular. This was described by Holl (8) and Pfitzner (9). The latter author points out the relationship of this sesamoid to the os calcis, talus, navicular, and the cuboid. This would imply other possibilities of fusion that we have not encountered. Wagoner (10) reports a case of bilateral fusion of the os calcis and cuboid. Weitzner (11) describes bilateral congenital synostosis of the astragalus and navicular. Several other authors (12, 13) have called attention to this type of anomaly. A rather unusual case of clubfoot with tibial-talocalcaneal coalition is presented by Sante (14). Burman and Lapidus (15) discuss

[1] From the William Beaumont Army Hospital, Fort Bliss, El Paso, Texas. Accepted for publication in June 1952.

TABLE I: CASES OF TARSAL COALITION DISCOVERED AT THE WILLIAM BEAUMONT ARMY HOSPITAL, FROM FEBRUARY 1951 TO FEBRUARY 1952

Case Number	Age	Complaint	Physical Findings	Roentgen Findings
1.	21	Pain in right longitudinal arch	Negative	Calcaneonavicular bar on right. Left foot normal
2.	22	Foot pain since childhood, aggravated by sustained periods of marching	Third degree pes planus, limitation of subastragalar motion, rigid bony prominences below both medial malleoli	Bilateral talocalcaneal bridge, diminution of Böhler's angle
3.	21	Pain, left foot, on excessive walking	Negative	Medial fusion of left talocalcaneal joint
4.	22	Pain, right foot, on prolonged periods of walking	Negative	Right calcaneonavicular bar
5.	20	Painful feet	Bilateral flat feet, limited eversion and inversion of right foot	Medial fusion of right subastragalar joint (talocalcaneal bridge)
6.	23	Bilateral painful feet aggravated by walking	Negative	Bilateral calcaneonavicular bar
7.	22	Pain, both feet, aggravated by walking	Bilateral limitation of inversion and eversion of both feet	Bilateral fusion of medial half of the subtalar joint
8.	19	Pain, right ankle, all his life, worse when walking	Prominence of right medial malleolus, limitation of inversion and eversion of right foot, second degree pes planus	Calcaneonavicular bar, right
9.	25	Painful feet, all his life	Third degree flat feet, rigidity of motion of ankles	Bilateral calcaneonavicular bar
10.	21	Pain, both feet, all his life, worse on right	Limitation of inversion, right foot	Right talocalcaneal bridge
11.	21	Pain, left foot for years	Limitation of inversion and eversion of left foot	Left talocalcaneal bridge
12.	22	Painful right foot	Limitation of inversion and eversion	Right talocalcaneal bridge
13.	23	Aching pain, left foot, since age five on prolonged standing and walking	Limitation of inversion	Left talocalcaneal bridge. Diminution of Böhler's angle
14.	22	Pain, both feet, past five years, worse on right	Limitation of eversion and inversion, right foot	Right calcaneonavicular bar
15.	40	Transient pain, right foot, on walking. Denies apophyseal tenderness	Pes planus	Right calcaneonavicular bar, right calcaneal spur
16.	20	Pain, both feet, on walking, since age of ten	Third degree flat feet, limitation of inversion and eversion, right foot	Right talocalcaneal bridge. Diminution of Böhler's angle
17.	21	Painful flat feet, relieved partially by arch supports	Limitation of inversion and eversion, bilateral, worse on right	Bilateral talocalcaneal bridge
18.	22	Pain, right arch, on long marches	Third degree pes planus, limitation of inversion of right foot	Right talocalcaneal bridge
19.	20	Bilateral painful feet for many years, aggravated by long periods of walking	Limitation of inversion and eversion, both feet	Bilateral talocalcaneal bridge
20.	21	Pain, left foot, for many years. Arthrodesis of left ankle at age sixteen with improvement. Unable to tolerate long periods of walking	Operative scar, left ankle, inability to invert or evert left foot	Arthrodesis, left ankle, left talocalcaneal bridge
21.	18	Painful feet, many years, aggravated by long periods of walking	Limitation of inversion and eversion, both feet, prominence of both medial malleoli	Bilateral talocalcaneal bridge

the functional disturbances caused by this sesamoid. Badgley (16) also discusses calcaneonavicular coalition, and mentions the fact that this anomaly may be asymptomatic. He also cites several cases having pain and rigidity.

The credit for calling attention to the talocalcaneal bridge belongs to Harris and Beath (4). They feel that this is a congenital fusion which may be incomplete or complete. Several cases proved at operation, as well as radiologically, are cited by

Coventry (6). As more emphasis is given to this type of coalition, an increasing number of cases will undoubtedly be recognized.

ANALYSIS OF CASES

Approximately 2,000 examinations for painful feet were made at the William Beaumont Army Hospital during 1951. A clinical and x-ray diagnosis of tarsal coalition was made in 21 patients (Table I). The type of involvement encountered on x-ray examination was as follows:

	Bilateral	Right	Left
Calcaneonavicular bar	2	5	0
Talocalcaneal bridge (medial one-half or complete)	5	5	4

At least in our experience the subastragalar type of lesion is the most common form of tarsal coalition. Any variance with the findings of others may be attributed to the technics employed in the x-ray examination of the subtalar joint.

The average age of the patients in this group was approximately twenty-two years. Many of the men stated that they had had foot pain for years, which has been the experience of several authors (3, 6, 7). The first symptoms are said to appear during adolescence. The trauma from periods of marching and training that our patients were engaged in could have precipitated the complaints.

Fig. 1. Routine oblique projection of feet for possible fracture. Arrows point to a "pseudo-calcaneonavicular bar." Subsequently proved to be normal. See Fig. 2.

If we exclude one patient (Case 15), who had been in the Army ten years, the average length of service for this group was approximately three months. Many men stated that they had had previous foot pain on prolonged periods of walking or standing. Undoubtedly many times the rigors imposed upon the inductee produced what appeared to be an acute condition. Upon a more careful inquiry into the patient's history, it was determined that symptoms had been present for several years prior to induction. Two men complained of foot pain since early childhood. We agree that tarsal coalition may exist and be asymptomatic if the patient does not undertake any undue exercise such as sustained marching.

It is conceivable that some of the men exaggerated their symptoms. It is generally agreed, however, that painful feet do occur with tarsal coalition, and the patient should be given the benefit of the doubt.

One of our patients (Case 20), with two months of service, had a triple arthrodesis five years prior to Army induction. He got along well in civilian life following the operation, but was unable to tolerate the training given to inductees.

Several of our patients returned to limited duty with the aid of arch supports and other conservative measures. None has been operated upon. The remainder of the group have been discharged to civilian life.

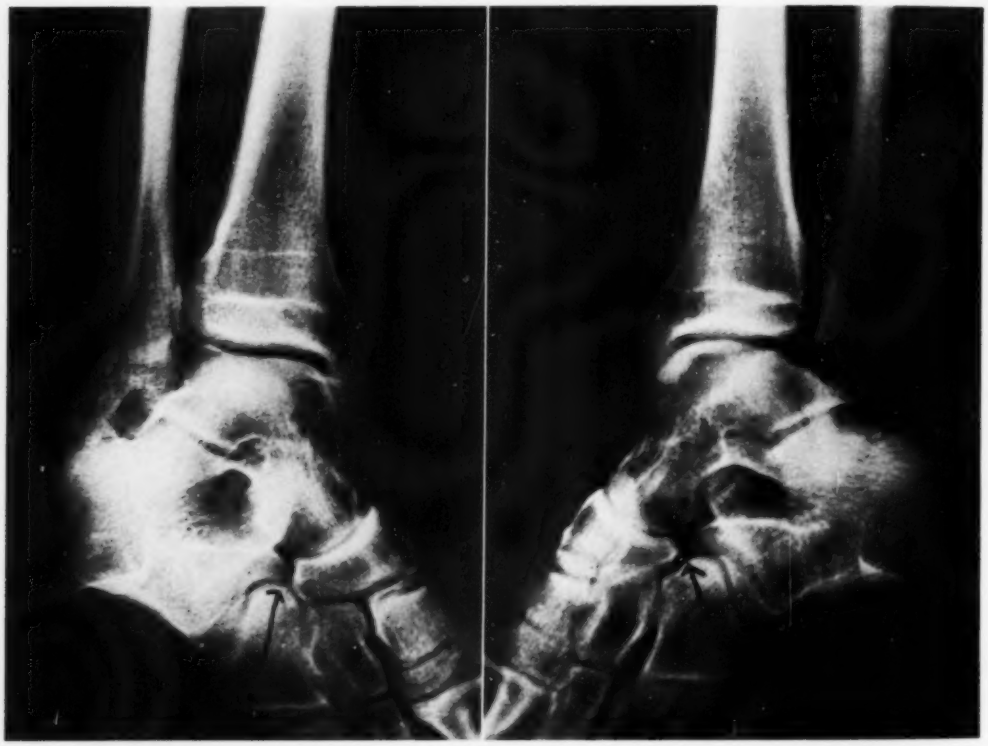

Fig. 2. Slightly different oblique projection of Fig. 1 to show normal calcaneonavicular relationship.

The positive physical findings were flatfeet either with or without limitation of inversion and eversion of the feet. In some instances the medial malleoli were prominent; however, gross deformities, such as valgus, described by several authors, were not prominent in our series.

ROENTGEN EXAMINATION

Lateral and external oblique (eversion)

projections of the feet are most valuable in demonstrating the calcaneonavicular region. Once the diagnosis of tarsal coalition is established by x-ray examination, we have found it helpful to repeat the oblique view, using a slightly different degree of obliquity. The value of this procedure is shown by Figures 1 and 2. In this instance, a diagnostic error was avoided by the repeat examination. This happened several times, and we have chosen the term "pseudo-calcaneonavicular bar" to describe the condition illustrated.

The subastragalar joint is best visualized in a lateral projection of the ankle or in the modified plantar view described by Sante (5). The latter has been called an axial view and referred to by orthopedists (4) as the "coalition view." The positioning of the patient is shown in Figure 3. Figure 4 demonstrates the importance of exact positioning. It is readily apparent that diagnostic errors of omission and commission may easily occur. Repeat studies may be necessary and are advocated in all suspicious cases to exclude blurring of the subtalar joint due to errors in positioning.

Orthopedists (4, 6, 7) have pointed out that the apparent discrepancy between the orthopedic diagnosis and the x-ray diagnosis is frequently attributable to difficulty in obtaining adequate views of the subastragalar joint (coalition view).

We have attempted to show a cross section of the two types of coalition. Those cases having a true calcaneonavicular bar show several interesting findings. The use of the term "bar" or "bridge" may be applied to those cases having a complete bony union (Figs. 5 and 6, Case 14), or those cases having incomplete bony fusion. In the latter instance the junction of the calcaneus and the navicular may be formed by syndesmosis (fibrous union) or a synchondrosis (cartilaginous union) (4). This type of union is seen in Case 8 (Fig. 7).

The subtalar type of fusion or the talocalcaneal type of bridge may be bony, fibrous, or cartilaginous. Radiologically bony union may be assumed when the joint is obliterated, either completely or incompletely;

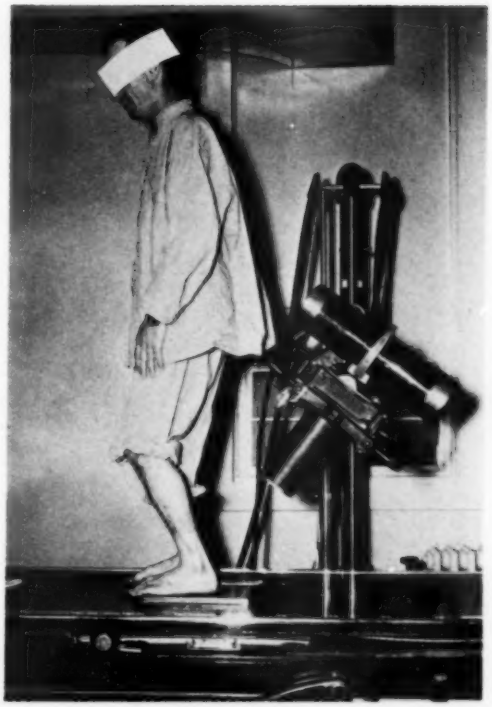

Fig. 3. "Coalition view" of subastragalar joint. Screen films: 36" distance, 15 ma., 55 kv. Tube angled 45° toward the heel. Knees flexed slightly forward to remove leg shadows.

usually it is of the latter type. The site of obliteration is generally at the sustentaculum tali or medial aspect of the joint.

Several other diagnostic points should be stressed. Tarsal coalition of the subtalar type is frequently indicated by the occurrence of an osteoarthritic spur adjacent to the talonavicular articulation. The lateral projection of the ankle may show obliteration of the subtalar joint. This is demonstrated in Case 16 (Fig. 8).

Complete bilateral fusion of the subastragalar joint is visible in Case 21 (Fig. 9).

DIFFERENTIAL DIAGNOSIS

The characteristic roentgen appearances outlined above, in association with a rigid flatfoot, makes diagnosis of tarsal coalition relatively easy. Arthritis—post-traumatic, rheumatoid, and tuberculous—may be a cause of some confusion. It is felt, however, that the structural alterations, together

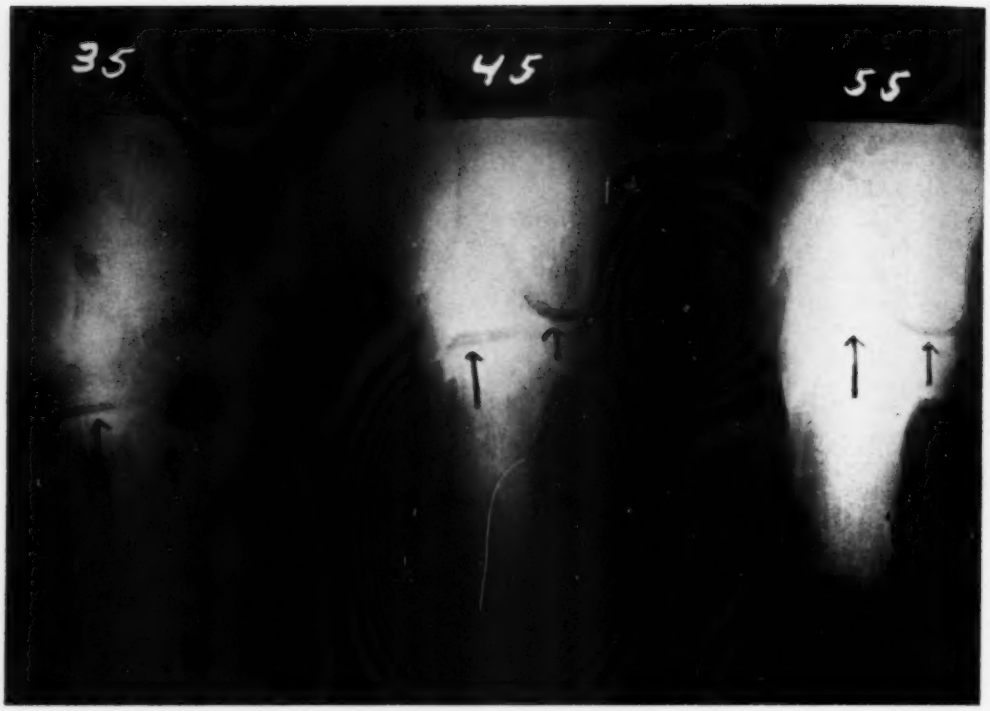

Fig. 4. Normal subtalar joint; short arrows point to medial aspect of joint and longer arrows toward lateral aspect. Normal subtalar joint seen when tube is angled at 45°. Distortion of joint seen when tube is angled at 35° and 55°. Correct positioning with proper angulation of the tube is extremely important.

with bony demineralization or sclerosis, will help to differentiate these conditions.

TREATMENT

Conservative treatment of tarsal coalition includes arch supports, lifts on shoe heels, limited activity, etc. In our experience little permanent relief is obtained except from restricted use of the feet. Since the feet of persons with tarsal coalition are more or less immobile, little can be anticipated from attempts to correct alignment and weight bearing by these measures. In fact, several patients who tried various types of arch supports had an increase in their symptoms and the supports were discarded.

In general, the mechanical disability can only be expected to respond to surgical correction providing, of course, the symptoms are severe enough to warrant such treatment.

Harris and Beath (4) advocate arthrodesis of the subtalar and talonavicular joints. Coventry (6) feels that triple arthrodesis is probably superior to a less extensive procedure. Since the talonavicular, talocalcaneal, and calcaneocuboid joints have a reciprocal action, a triple arthrodesis would seem to be the procedure of choice. This type of foot stabilization has emerged from the many less extensive surgical procedures used in correcting malunited fractures and deformities as the most satisfactory solution for foot disabilities.

Simple excision of the offending bony "bridge" or "bar" is not recommended on the basis of the few cases in which it has been attempted. Arthrodesis should be postponed until the foot has reached its normal growth in the latter part of adolescence unless symptoms prove to be entirely disabling. It should probably not be performed before the age of ten or twelve years.

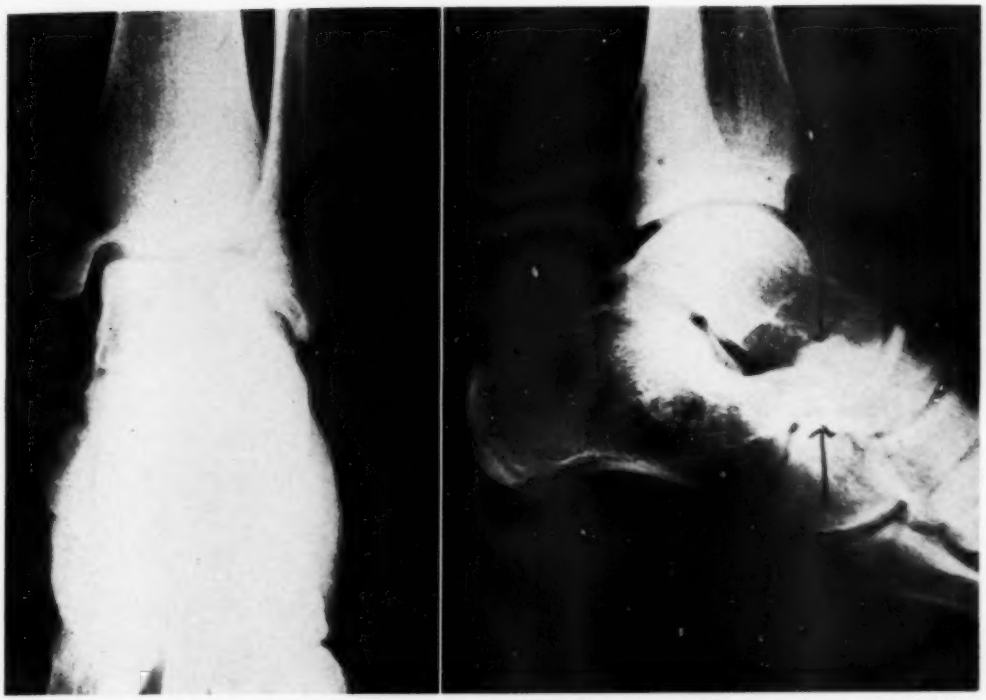

Fig. 5. Case 14. Calcaneonavicular bar. Lateral projection with arrows pointing to the bony tongue uniting the calcaneus and navicular.

SUMMARY AND CONCLUSIONS

1. Twenty-one cases, radiologically verified and clinically confirmed, of tarsal coalition of the calcaneonavicular and talocalcaneus types have been described.

2. The term "peroneal spastic flatfoot" is considered obsolete. We concur with others that "tarsal coalition" or "arthritic spastic flatfoot" is a more appropriate and descriptive term.

3. The "coalition view" of Harris and Beath is described, with particular attention to the roentgenologic factors necessary to reveal the talocalcaneal type of coalition. The oblique view of the foot is recommended to show the "calcaneonavicular bar" or "talocalcaneal bridge."

4. Attention is called to the fact that tarsal coalition may be asymptomatic. However, more than usual activity (march-

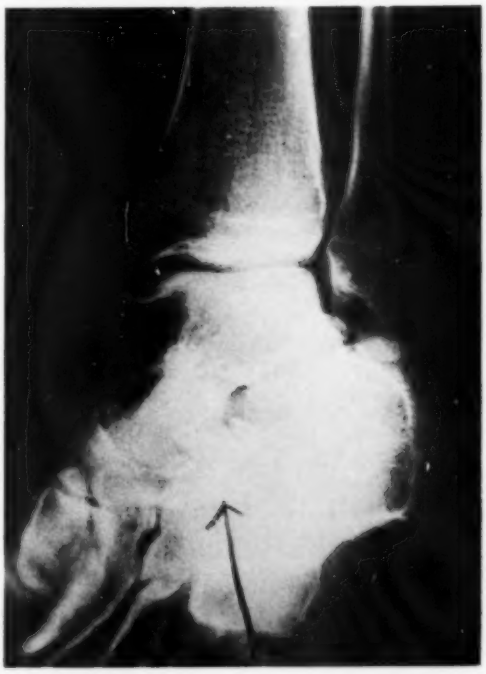

Fig. 6. Case 14. Calcaneonavicular bar. Complete bony bridge uniting calcaneus and navicular.

Fig. 7. Case 8. Calcaneonavicular bar—incomplete union evidenced by thin radiolucency separating these two bones in the oblique projection. Lateral view gives the erroneous impression of a synostosis.

Fig. 8. Case 16. Lateral projection demonstrating obliteration of subtalar joint (posterior arrow). Anterior arrow pointing to bony spur which is a frequent associated finding in tarsal coalition.

ing, etc.) may precipitate symptoms. Symptoms usually appear after puberty.

5. The history in patients with tarsal coalition is in general uninformative. The usual complaint of pain in the feet cited in our material is a good example. The physical finding of limitation of inversion and eversion is important.

6. Treatment may be conservative. Triple arthrodesis has been advocated and performed with success in cases with severe pain.

7. Differential diagnosis is not difficult. However, previous trauma, *e.g.*, fractures of the os calcis, with post-traumatic arthritis, may cause confusion. Rheumatoid arthritis must also be kept in mind, but other joints are affected.

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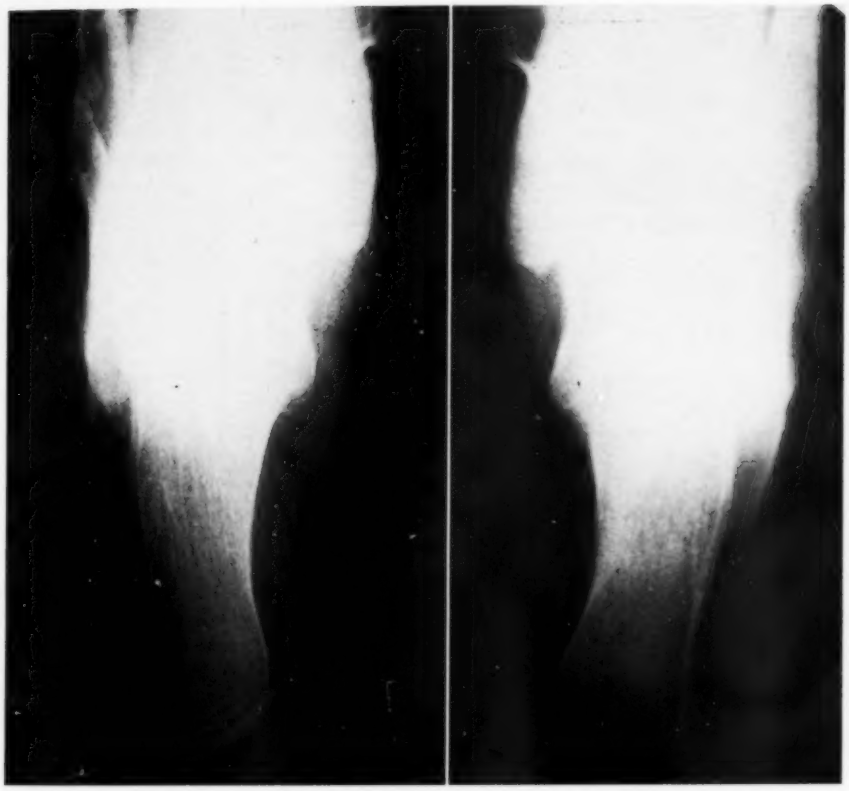

Fig. 9. Case 21. "Coalition view" showing bilateral complete fusion of subtalar joint.

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Fast Neutron Dosimetry[1]

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THIS PAPER summarizes the recent work on fast neutron dosimetry done by the Health Physics Division of the Oak Ridge National Laboratory.

Neutrons do not ionize directly, but by various reactions with tissue they produce particles which do ionize. In the case of fast neutrons the important reactions are the elastic collisions with hydrogen, carbon, nitrogen, and oxygen atoms. The recoil nuclei are charged and spend the energy gained from the neutron by ionization and excitation of the tissue atoms. Thus, it is important to measure the amount of energy imparted to a gram of tissue. Accordingly the unit accepted for measuring the tissue dose of fast neutrons is the roentgen-equivalent-physical (rep), which is the amount of radiation needed to dissipate 93 ergs per gram of soft tissue. The unit as defined cannot be measured directly in practice. However, the amount of ionization produced by the radiation is a fairly accurate index of the amount of energy used in exciting and ionizing tissue.

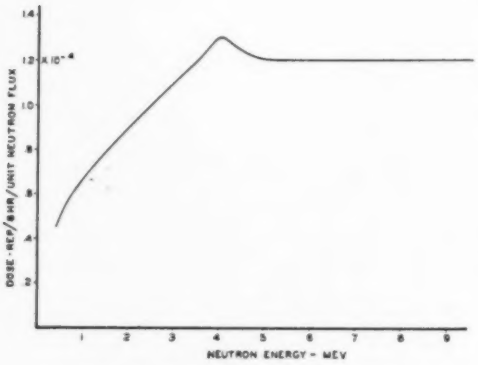


Fig. 1. First collision dose curve.

We wish to discuss two methods that have been developed specifically for measuring the dose due to fast neutrons in the presence of gamma radiation.

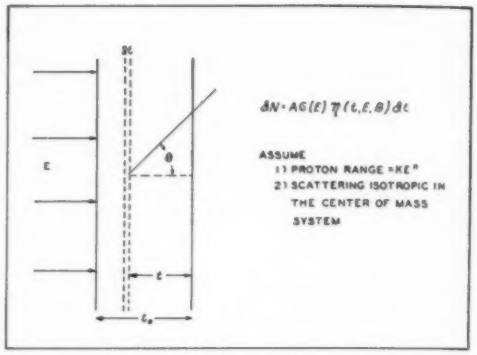


Fig. 2. Schematic drawing of a proton radiator.

COUNT-RATE DOSIMETER

The first principle is the fact that a counter can be so designed that its count rate dependence on energy is the same as the variation of the dose with energy. The amount of energy that is given to the hydrogen, carbon, nitrogen, and oxygen atoms in a gram of tissue can be calculated if the various cross sections are known, and if one assumes that the scattering of all the atoms is isotropic in the center of mass system. The result of such a first collision calculation is shown in Figure 1.

The details of a detector which has a dependence on neutron energy that approximates this curve have been described (1). We will now indicate how the response of such a detector can be calculated. Figure 2 is a schematic drawing of a proton radiator which may be a plane slab of paraffin or polyethylene. The number of protons dN contributed from dt as a result of elastic collisions is

$$dN = A\sigma(E)\eta(t, E, B)\, dt \qquad (1)$$

[1] Presented at the Thirty-eighth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 7–12, 1952.

[2] From the Health Physics Division, Oak Ridge National Laboratory.

where A is a constant, $\sigma(E)$ is the hydrogen cross section as a function of the neutron energy E, and the quantity $\eta(t, E, B)$ is the fraction of those protons produced in dt which reach the surface of the slab with an energy equal to or greater than B, the bias energy. If one assumes that the range of

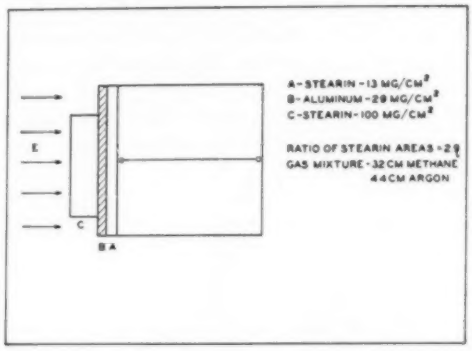


Fig. 3. Schematic representation of count-rate dosimeter.

protons in the slab is expressed as kE^n, where k and n are constants, and if scattering is isotropic in the center of mass system, then η can be computed. The integration of equation (1) over all dt then gives for $E \leq E_0$,

$$N = c_1\sigma(E)\left\{\frac{2E^n}{2n+3} + B^n\left[\frac{4n}{6n+9}(B/E)^{3/2} - \frac{2}{3}\right]\right\} \quad (2a)$$

and for $E \geq E_0$ and $E_0 \gg B$,

$$N = c_1\sigma(E)E_0^n\left[1 - \frac{2n+1}{2n+3}(E_0/E)^{2n/(2n+1)}\right] \quad (2b)$$

where E_0 is energy of the proton having a range t_0. Similarly the response of a hydrogenous counting gas is

$$N = c_2\sigma(E)\{1 - B/E\} \quad (3)$$

and the response of a thick slab of paraffin covered by a layer of metal of thickness corresponding to a proton energy E_1 is

$$N = c_3\sigma(E)E^n\left\{1 - \frac{2n+1}{2n+3} - \left(\frac{E_1}{E}\right)^n + \frac{2n+1}{2n+3}(E_1/E)^{n(2n+3)/(2n+1)}\right\} \quad (4)$$

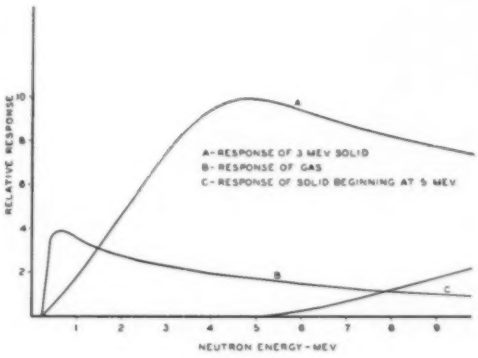


Fig. 4

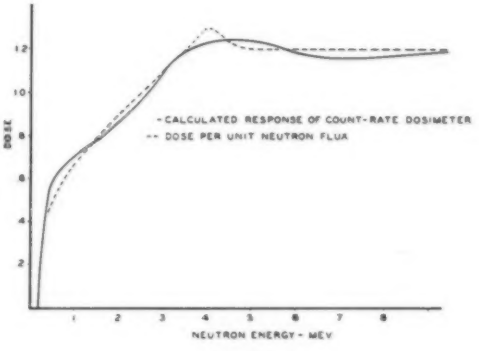


Fig. 5

A representation of the three proton sources is shown in Figure 3, for the case where $E_0 = 3.0$ mev, $E_1 = 5.0$ mev, and $B = 0.2$ mev. Figure 4 shows the response of the three sources where curves A, B, and C are plots of equations 2, 3, and 4, respectively. If curves A, B, C are added, the solid curve in Figure 5 is obtained. The dashed curve is the dose curve and a comparison with the calculated response is shown.

The counters were tested with monoenergetic neutrons and the results are shown in Figure 6. From this curve it is evident that the tissue dose may be measured by simply counting the number of pulses produced in a carefully designed proportional counter. Gamma discrimination is accomplished by setting the bias on the electronic circuit greater than the largest gamma pulses.

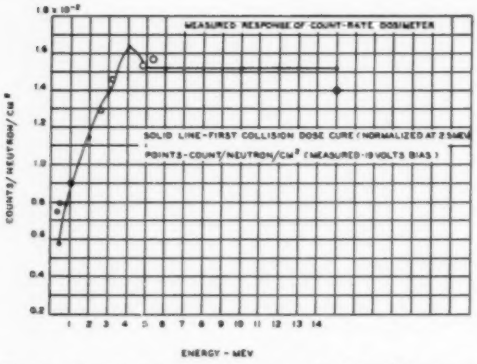
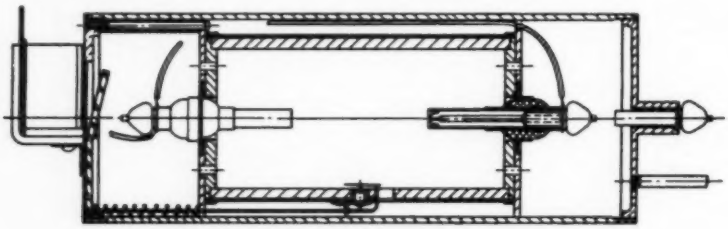

MEASURED RESPONSE OF COUNT-RATE DOSIMETER
SOLID LINE-FIRST COLLISION DOSE CURE (NORMALIZED AT 2 MEV)
POINTS-COUNT/NEUTRON/CM² (MEASURED-19 VOLTS BIAS)
COUNTS/NEUTRON/CM²
ENERGY - MEV

Fig. 6. Results when counters were tested with monoenergetic neutrons.

ing the first collision dose as a function of energy for both tissue and ethylene, it is seen that the ratio ethylene dose/tissue dose is essentially independent of neutron energy. A very useful ionization chamber developed by Rossi and Failla (3) uses exact tissue equivalent walls and a tissue equivalent gas. The use of exact tissue equivalent materials can be important for neutrons in the low energy region (less than 200 kev). Their chamber is very useful when a measurement of total tissue ionization due to gamma radiation and neutrons is desired.



Half-Scale

ABSOLUTE FAST NEUTRON DOSIMETER

Fig. 7. Cross section of a counter which is calibrated with an alpha source built into the wall.

PULSE INTEGRATION METHOD

The application of the preceding principle of measuring fast neutrons involves very simple instrumentation, but has limited application due to the fact that such an instrument is somewhat directional. The purpose of this section is to describe an instrument which is more complicated but is not directional.

This instrument uses a proportional counter which is filled with ethylene and is lined with a layer of polyethylene whose thickness is greater than the range of the most energetic protons. Thus, the energy dissipated by the recoils in the gas volume represents the original energy dissipated by the neutrons in the same volume of gas in accord with the Bragg-Gray principle (2). A measure of the total ionization produced in the cavity is proportional to the energy dissipated per gram of ethylene. Calculat-

A direct current measurement of the number of ions produced in the counter would be a satisfactory method of determining the dose except for the fact that this measurement is also sensitive to gamma radiation. In order to achieve a gamma insensitive instrument, the number of ion pairs is determined by adding up the pulse heights. This allows a bias to be used so that the smaller gamma pulses are not counted. The pulse height is proportional to the number of ion pairs provided the electrons all remain free in crossing the counter to the wire, and if the amplifier time constant is made longer than the time of collection of electrons.

Figure 7 shows the cross section of a counter which is calibrated with an alpha source built into the wall. The counter has a volume that is known by using "field tubes" which are held at the potential appropriate to their radius. By this means

the mass of gas is known and an absolute calibration can then be made by reference to the known energy of the alpha particle.

Figure 8 shows a proportional counter that uses the Bragg-Gray principle but does not contain field tubes or alpha source. This counter is small (gas volume is 1 cm. diameter and 6 cm. length) and is used for phantom-type measurements. It may be calibrated with the standard counter just described.

A device for automatically adding the pulse heights has been reported (4). Figure 9 shows the basic principle of operation. The pairs of circles represent the usual binary scaling unit. In normal operation, the first pulse fires indicator one, and the second count turns off indicator one and activates indicator two. The third count leaves both lights "on," etc. Since we wish to add pulse heights, a 10-volt pulse might give two counts as compared to a 5-volt pulse which gives one count. A, B, C, and D are discriminators which fire at 5, 10, 20, and 40 volts. Note that they feed into progressively higher positions in the binary scaling unit. When a 5-volt pulse arrives, one count is added, since only discriminator A conducts. A 10-volt pulse fires B and two counts are added due to B. Tube A also conducts, and a count is added to indicator one, if it is "off" when the 10-volt pulse arrives. If the indicator one is "on" when the 10-volt pulse arrives, it is effectively erased, for the second stage is already busy due to the pulse from B. Thus, the only effect of A is to alternately add and subtract a count and the net result is two counts per 10-volt pulse. Similar reasoning shows that a 20-volt pulse gives an average of four counts, while a 40-volt pulse gives an average of

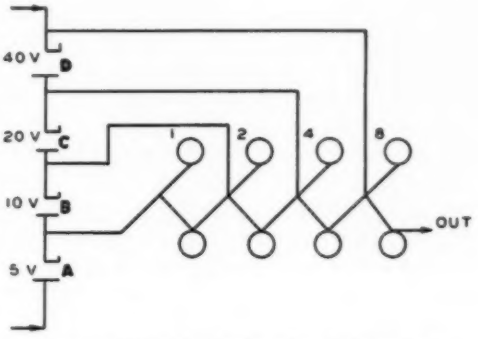
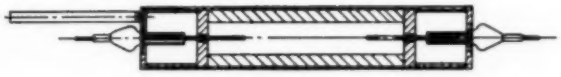


Fig. 9. Schematic drawing of pulse integrator.



Half-Scale

DOSIMETER FOR FAST NEUTRON PHANTOM MEASUREMENTS

Fig. 8. Proportional counter that uses the Bragg-Gray principle but does not contain field tubes or alpha source.

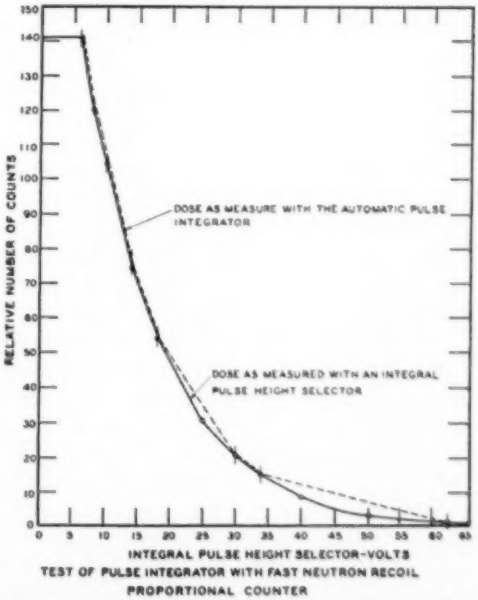

RELATIVE NUMBER OF COUNTS
DOSE AS MEASURE WITH THE AUTOMATIC PULSE INTEGRATOR
DOSE AS MEASURED WITH AN INTEGRAL PULSE HEIGHT SELECTOR
INTEGRAL PULSE HEIGHT SELECTOR-VOLTS
TEST OF PULSE INTEGRATOR WITH FAST NEUTRON RECOIL PROPORTIONAL COUNTER

Fig. 10. Graph illustrating accuracy of pulse integrator.

eight counts. The circuit is extremely simple since there is no need to use anti-coincidence to prevent addition of pulses from lower level discriminators.

Figure 10 illustrates the accuracy of the pulse integrator. The area under the solid line represents the dose that would be measured by using an integral-type pulse height selector. The area under the dashed curve would be measured directly with the integrator. The difference is about 5 per cent.

This instrument for measuring the fast neutron tissue dose is completely analogous to the ionization chamber, except of course, it does not measure gamma radiation. The rejection of gamma requires a bias B, and this causes some loss of neutron energy under the bias.

The fraction of energy loss is approximately $(B/E)^2$, which is small when E is moderately larger than B. In practice B can be 200 kev, thus the correction is small for $E > 500$ kev.

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SUMARIO

Dosimetría de los Neutrones Rápidos

Los neutrones no yonizan directamente, sino que por medio de varias reacciones con los tejidos, producen partículas que sí yonizan. Tratándose de los neutrones rápidos, las reacciones importantes son las colisiones elásticas con los átomos de hidrógeno, carbono, nitrógeno y oxígeno. Los núcleos repulsados quedan cargados y dedican la energía obtenida del neutrón a la yonización y excitación de los átomos de tejido, por lo cual resulta importante medir la cantidad de energía transmitida a un gramo de tejido. La unidad aceptada para medir la dosis histológica de neutrones rápidos es el roentgen-equivalente-físico (ref), que representa la cantidad de radiación necesaria para disipar 93 ergios por gramo de tejido blando. En la práctica, no puede medirse directamente esa unidad en la forma en que se define. No obstante, la cantidad de yonización producida por la radiación constituye un índice bastante exacto de la cantidad de energía usada para la excitación y yonización del tejido.

Se han elaborado específicamente dos métodos para medir la dosis de neutrones veloces en presencia de radiación gamma. El primero utiliza un contador diseñado de modo que la velocidad con que registra la energía sea idéntica a la variación de la dosis de acuerdo con la energía usada. La instrumentación necesaria es muy sencilla, pero tiene aplicación limitada, por ser la misma algo "directoria." El segundo método es más complicado, pero el instrumento usado no es "directorio," constando de un contador proporcional que está lleno de etileno y forrado de una capa de polietileno, cuyo espesor excede el alcance de los protones más enérgicos. La energía disipada en las reculadas del volumen de gas representa, pues, la energía primitiva disipada por los neutrones en el mismo volumen de gas de acuerdo con el principio de Bragg-Gray.

DISCUSSION

H. H. Rossi (New York, N. Y.): It may be well to point out two facts. One is that the selective determination of the tissue dose delivered by neutrons is one of the most urgent problems of radiological physicists who must evaluate health hazards around reactors or cyclotrons; the other is that to my knowledge the instruments described by Dr. Hurst are just about the only ones designed to perform such a measurement.

The tissue equivalent ionization chamber as developed at our laboratory is capable of measuring neutron doses. Neutrons, however, are usually accompanied by gamma radiation and this chamber will register both. Since the biological effectiveness of these radiations is different it is necessary to know the relative value of both components. Therefore, if one uses the tissue equivalent ionization chamber one must supplement the information obtained, employing devices which determine either component alone. It is clear that instruments of the types which have been described are extremely useful for this purpose.

As far as the two instruments are concerned, the first one mentioned is a very compact unit but, as Dr. Hurst pointed out, it has a directional response which limits its usefulness considerably, since neutrons do not usually all come from a known direction. The second device described, however, is entirely free from this objection and also embodies a very ingenious and efficient circuit. It may be of interest to report that preliminary experiments performed by Dr. Hurst and myself have indicated that there appears to be good agreement between this latter device and a tissue equivalent ionization chamber when both are exposed to a polonium beryllium source.

A limitation of this device is that neutrons below about 200 kev cannot be measured because of the bias which must be chosen. I believe that this limit might be substantially lowered if the gas pressure in the proportional counter were decreased. Once the pressure is sufficiently low so that virtually all ionizing particles cross the counter, the choice of bias would be more nearly determined by the relative specific ionization of particles rather than by the relative values of proton range and counter dimensions. If lowering of pressure should cause an undue loss of sensitivity, the size of the counter might be increased accordingly, leaving the total amount of gas in the cavity constant.

Failures, Flops and False Localizations in Tracer Technic[1]

K. E. CORRIGAN, Ph.D., and H. S. HAYDEN, Ph.D.
Detroit, Mich.

IN THE DEVELOPMENT of any new technic it seems inevitable in the light of human experience that errors will be committed. Sometimes these are humorous, embarrassing, or both, at the time they occur, and often in the light of knowledge a few years later they look quite ridiculous. At the same time it is essential that these undesirable incidents be brought to light and considered in detail, for it is from them that we derive much of our working knowledge of the perfected technic. They also should be called to the attention of new workers in the field so that they need not be repeated.

After the inauguration of the full-scale clinical isotope program at Harper Hospital, our first embarrassing moment occurred in May 1947, when the program was less than six months old. By this time we had conducted studies on our first 10 known cases of carcinoma of the thyroid (1 of which is discussed later), and had developed our technic to the point where we were successful in obtaining the right conclusions on our first unknown case. At this time we were presented with the problem of a patient[2] with a 3×5 cm. mass in the left side of his neck. The mass had been enlarging rapidly. The patient had a long history of undiagnosed pulmonary disease, and the mass had been suspected of being Hodgkin's disease, carcinoma of the lung with direct extension into the neck, and carcinoma of the thyroid, but none of these diagnoses could be established. One of the country's greatest endocrinologists had gone on record as diagnosing this mass as "a rare sarcoma of the thyroid with metastases," although this fact was not known to us at the time.

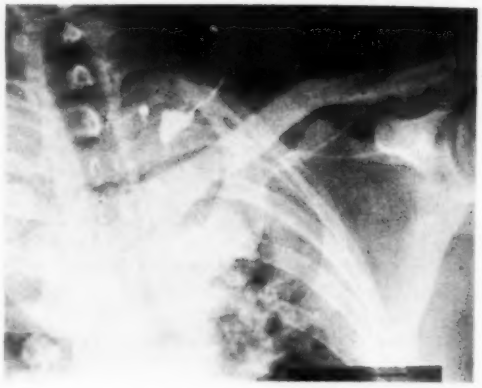


Fig. 1. Postoperative roentgenogram.

The tracer study showed a distorted thyroid with some retrosternal extension and a poor concentration and very poor retention of the tracer in the mass. In reviewing the counts and the entire tracer pattern we now realize that it is a perfect pattern of thyroiditis, but at the time we believed it to be carcinoma of the thyroid. Partly for this reason the patient's condition was explored surgically and the surgeon encountered a massive tuberculous abscess which was not expected. The patient had been studied for pulmonary disease at several of the country's largest centers, and no diagnosis of tuberculosis had ever been established. The size and shape of the abscess sac after it was collapsed and filled with radiopaque medium is shown in Figure 1. The avidity of certain microorganisms, including the bacillus of human tuberculosis, for I^{131} was not known (1) and, ridiculous as the error may appear now, it is hard to see how it could have been avoided at that time.

Subsequently we have encountered 28 diagnostic problem cases which proved to

[1] From Harper Hospital, Detroit, Mich. Presented at the Thirty-eighth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 7–12, 1952.
[2] See Acknowledgment 1.

be thyroiditis. Some of these had abscesses, although most of them did not, and none were tuberculous. Up to this time we have never again fallen into the error of mistaking one for a neoplasm. An active thyroiditis is characterized by the fact that foci of hyperactivity outline the acute area, which will be quite inert in its central portion. Parts of the gland which have

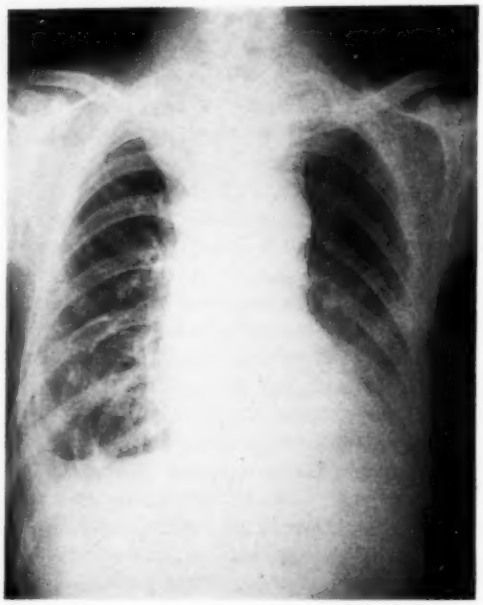


Fig. 2. Mediastinal mass (thyroid).

already been damaged by the inflammatory process appear to be completely without function. The residual normal tissue, if any, has a perfectly normal intrinsic function and the active foci do not exhibit the abnormal drop characteristic of malignant change. The cases do not show a malignant type of excretory function.

In one case a patient[3] was brought in for tracer study with a clinical diagnosis of acute thyroiditis and the tracer pattern indicated carcinoma. A total thyroidectomy was performed immediately, and both the carcinoma and the thyroiditis were proved histologically. It is evident that by the onset of the acute thyroiditis

[3] See Acknowledgment 2.

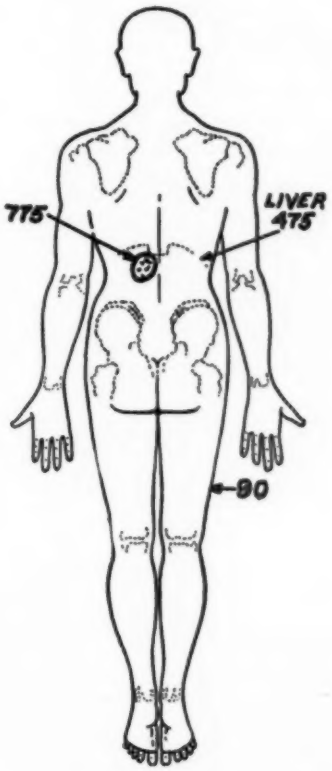
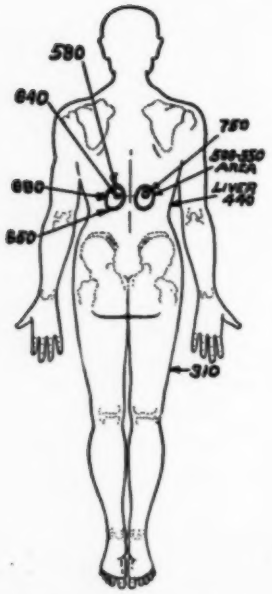


Fig. 3. Tracer map showing trapping of tracer by impaired kidney.

this patient was saved from something more disastrous, since the cancer had shown no clinical signs of its presence. The case again demonstrates the necessity for considering and searching out all possible entities in a tracer study, for a condition more serious than the most obvious one may be present.

In October 1948, we encountered a condition which contributed a considerable amount of amusement to some of our staff members. The patient[4] in this case was an elderly Oriental who, in addition to being quite ill, was exceedingly suspicious of everybody and particularly of the Geiger counter, and quite inclined to be unco-operative. His array of illnesses was impressive. His proved conditions noted on the chart were chronic glomerulone-

[4] See Acknowledgment 3.



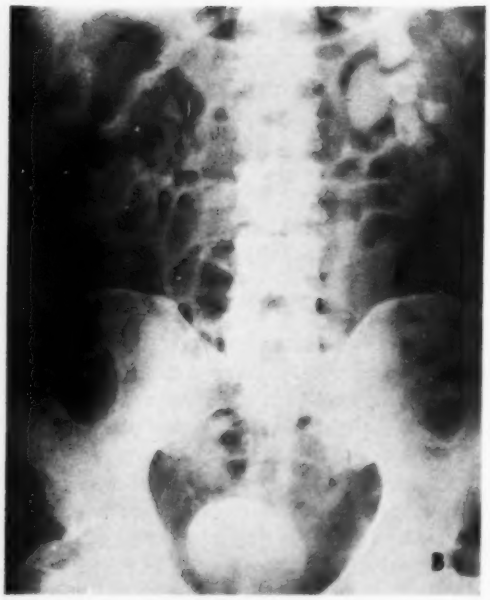


Fig. 4. A. Tracer map. B. Pyelogram in standard anteroposterior projection.

phritis, anemia, uremia, arteriosclerotic heart disease, bronchopneumonia due to undetermined cause, adenoma of thyroid gland, latent lues of undiagnosed site, and ichthyosis. He also had gastric distress of unknown origin which required medical care.

The patient was referred for a tracer study due to the large mediastinal mass shown in Figure 2. This proved to be a mediastinal thyroid, the identification of which was routine. He also had a very high gastric retention which slowed the concentration and made counting difficult. As the stomach finally cleared, it was discovered that he still had a high retention of the radioactive tracer in the left flank region. This was traced down finally to a rather large area next to the spine on the left side and extending over the levels of the twelfth thoracic and first lumbar vertebrae. The localization (Fig. 3) was so definite that temporarily we believed it to be a functioning metastasis from a carcinoma of the thyroid. Its rate of decrease was very slow and its outline quite clear. When the localization was clearly demonstrated on the twenty-six-hour count, we showed it proudly to some of our clinical friends and the patient's own physician. Later we tried to demonstrate it again, and great was our embarrassment when we discovered the localization had utterly and totally disappeared. The explanation, of course, then became very simple. The patient had a blockage of the left kidney, which had collected a fairly large portion of the tracer and then released it all at once. A pyelogram was requested but could not be taken due to the patient's clinical condition, including the fact that his blood nitrogen was above the safe level for this procedure.

Subsequently this phenomenon has been observed a number of times. A specific example[5] in which the entire left kidney is clearly outlined due to a blocked ureter and a spot is shown in the upper pole of the right kidney was studied for the purpose of demonstrating this condition (Fig. 4A). The precision of this localization demonstrates the improvement in technical equipment which has taken place in about four years. Figure 4B shows the pyelogram

[5] See Acknowledgment 4.

verifying the localization. Impaired kidney function is not a rare condition and the possibility of interference from this source in the localization of a spinal or posterior thoracic metastasis needs to be kept in mind.

Spinal metastases from carcinoma of the thyroid are an extremely unpleasant subject in general, and one of the most important. A very tiny lesion bearing upon this vital cord, which is encased in a non-expandable tube, can do a tremendous amount of damage; yet, due to the depth of the spinal canal within the body, particularly in a heavy person, vitally important spinal metastases are extremely hard to identify and localize accurately.

The patient[6] whose tracer map is illustrated in Figure 5A had had a very large goiter for at least fifteen years. It was diffuse and without nodules. At various times it had been diagnosed as diffuse nontoxic and diffuse toxic, the records at the time of admission to the hospital showing toxicity. The patient's immediate medication history is not clear, and there is reason to believe that she had taken unauthorized iodine recently before the study. Also, as is not uncommon in neurosurgical cases, the tracer study had to be hurried and was never really completed. There was only poor total thyroid uptake and general nonuniform distribution. There were extreme hyperactivity in the left lobe area and definite concentration behind the sternum, but with the technic and equipment then available, it was not possible to prove localization in the rib or intrathoracic regions outside the mediastinum that were demonstrated to us on the radiograph (Fig. 5B), and no localization could be made over the upper spine. The neurological examination indicated an extradural cord pressure at the level of the sixth or seventh cervical vertebral body, presumed to be metastatic thyroid carcinoma.

At operation a metastasis was found at a level appreciably higher than its neurological position, and the surgeon was forced to explore upward until he found it. A precision tracer localization of this metastasis would have been a great aid to the

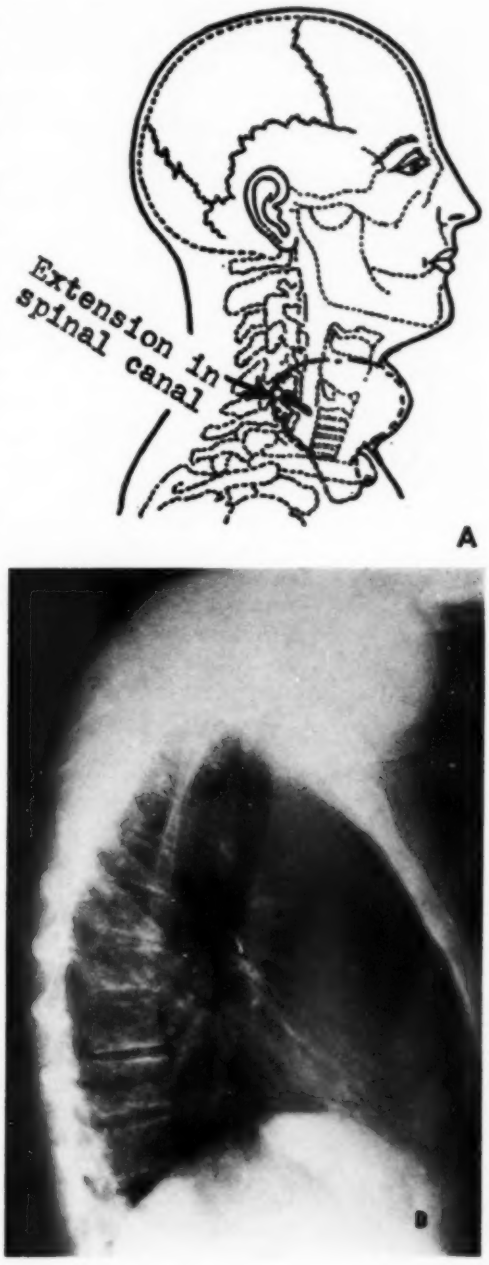


Fig. 5. A. Tracer map showing carcinoma of thyroid with extension into spinal canal. B. Roentgenogram.

[6] See Acknowledgment 5.

surgeon, but due to its poor function and the fact that it was not only directly behind but actually inside of the arc of the grossly enlarged and partially hyperactive thyroid, a tracer localization was impossible. The tissue, however, was proved carcinoma of the thyroid and the finding of carcinoma of the thyroid with metastasis was completely substantiated.

During the first month of our program (Jan. 24, 1947) we studied a case[7] which had even a less satisfactory outcome from all points of view. The patient on stepping out of bed had experienced pain in his feet and before his doctor could reach his home was completely paralyzed from the waist down. Later he recalled a history of pain in the left chest and vague pain and numbness in the left foot, progressing gradually to both feet and legs. He was taken to a hospital immediately, where a neurosurgeon performed a decompression of the collapsed fifth dorsal vertebral body and obtained a biopsy. This was read as metastatic adenocarcinoma of the thyroid and the patient was referred for an I^{131} tracer study. A good localization was obtained over the site of the known lesion and isotope therapy was started. The patient received small doses over the following three months. In May 1947, he was transferred to a public institution, where he died July 18, 1947.

On postmortem examination a carcinoma of the prostate, the size and shape of a small grapefruit, was discovered, although it had not been even suspected in any of the three hospitals where the patient had spent parts of his last seven months. There were no detectable metastases having the characteristics of prostatic carcinoma and no bony lesions were found by x-ray or any other type of examination. Examination of the pathological specimens with the Geiger counter gave a weak trace of activity over the fifth thoracic vertebral body and a trace of activity over the thyroid. There was also a trace of activity, not more than ten per cent above background, in the pituitary but no other indications of activity. The last radioiodine, a dose of 5 mc., had been administered to the patient one month before he died.

In trying to evaluate this case for scientific purposes, there are a number of areas in which doubt can never be entirely cleared. In the first place, it is obvious that neither we nor any one else at that time realized that a very small trace of radioiodine will concentrate in the edematous area around any surgical trauma. In reviewing the figures, however, it is found that a very much higher concentration, of the order of forty times more, was actually present in the lesion than should be expected from this cause. Enough time and enough radioiodine had been administered to have significantly changed, if not completely destroyed, the lesion between the period when it was first observed and at the time of death. The histological slides have been reviewed by a number of pathologists and have, in fact, been shown to a national meeting by the original pathologist. The final interpretation of the biopsy slides is still a matter of controversy. In our own statistics this case is considered a failure, but it can never really be definitely proved whether the patient had a double primary (2) or whether we made a completely false localization. Again, if we were in a poor position, we at least had excellent company, but it is important to realize that where surgical or any other trauma exists, the interpretation of any isotope localization must be approached with extreme caution.

The identification of mediastinal shadows and the localization of toxic retrosternal thyroids which do not show in the roentgenogram are subjects which we have discussed before this Society several times and have presented before the American Medical Association (3). As the usual thing the identification is very simple, straightforward and reliable but on occasion, and with the exercise of a certain degree of stupidity, it is possible to encounter a considerable amount of difficulty in this respect also. The case illustrated

[7] See Acknowledgment 6.

in Figure 6A and B[8] was a successful localization and is being shown for contrast to the one that follows. This was a massive thyroid cyst with islands of functioning thyroid tissue. This is the usual situation and is very easily identified (4). In this particular case the identification, which had to be made very quickly, was a major factor in saving the patient's life. He was in respiratory distress and within eight hours after the tracer was started suffered complete collapse of his respiratory mechanism. At that time the tracer technic was too new to be generally accepted and one of the country's leading general surgeons dismissed the possibility of operating on the patient, who obviously was very near death, with the chart note "patient is *in extremis*—would not withstand surgery."

A team of thoracic surgeons[8] and an anesthesiologist,[9] however, decided to go ahead more in hope than belief that the tracer finding was correct and, working far into the early hours of the morning, they first restored the oxygen balance to a point that made operation possible. When the patient was transferred to the operating room the Geiger counter was used to outline the details of the condition. The right lobe was in essentially normal position and was connected to the rest of the mass by a continuous line, apparently the isthmus. The left lobe was displaced downward behind the sternum and, together with the mass, was outlined on the patient's skin with a pen before the sterile preparation of the skin was started. They then proceeded to remove the mass which is illustrated in Figure 7A. The appearance of the cyst, showing the wall after it was emptied of 140 c.c. of fluid, mainly fresh blood, is shown in Figure 7B. This patient is still alive and well after nearly four years.

In contrast to this we have two roentgenograms (Fig. 8) taken two months apart, showing a rather rapidly expanding

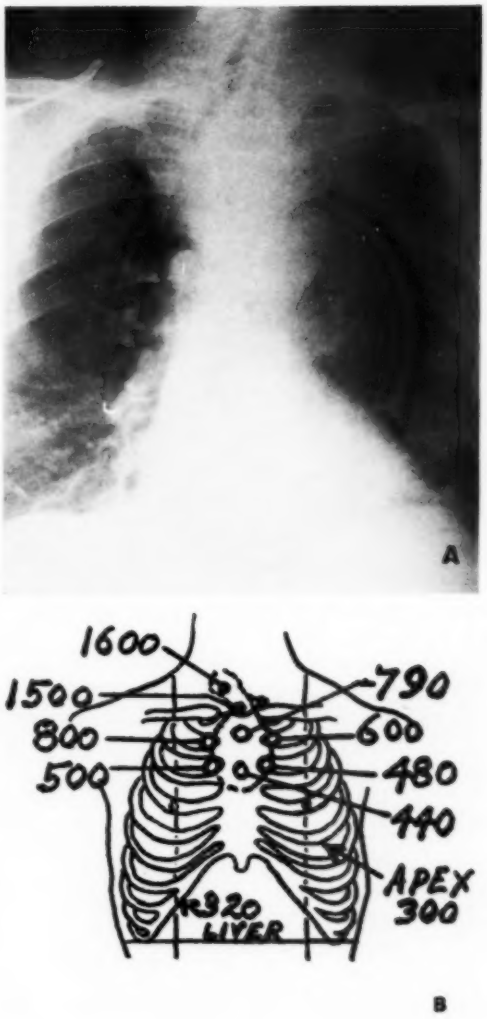


Fig. 6. A and B. Radiograph and tracer map demonstrating retrosternal thyroid mass.

mediastinal mass. Again, reviewing the case[10] we find ourselves in excellent company in consideration of some of the clinical diagnoses which were given.[11] At the time the patient was finally subjected to a tracer study she was in a critical condition. Although it is not entirely visible in the

[8] See Acknowledgment 7.
[9] See Acknowledgment 8.

[10] See Acknowledgment 9.
[11] It must be noted that Dr. L. Reynolds had made the correct diagnosis on this patient without equivocation six months prior to the beginning of this incident.

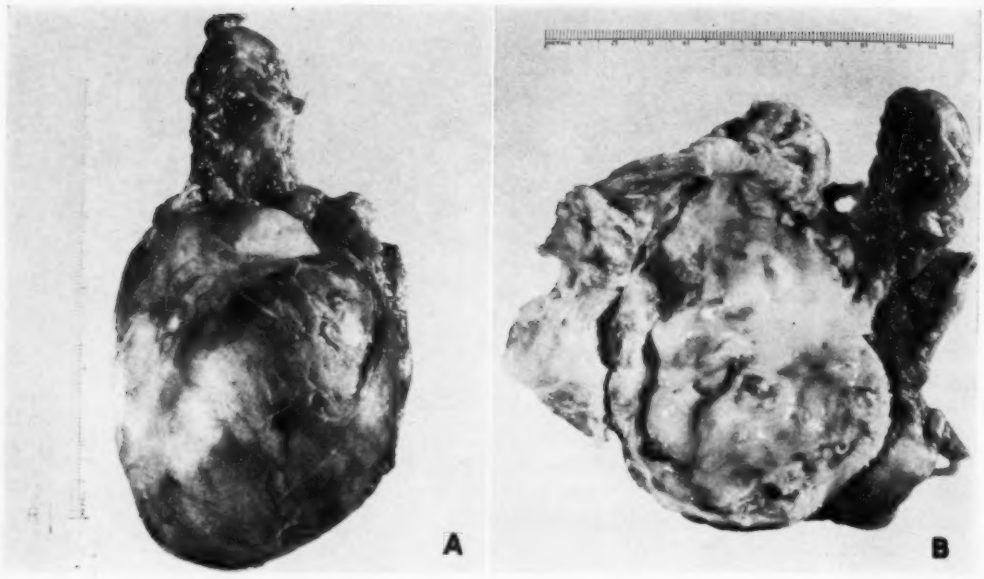


Fig. 7. A. Thyroid cyst as removed, showing conformity to tracer map. B. Thyroid cyst drained, showing structure.

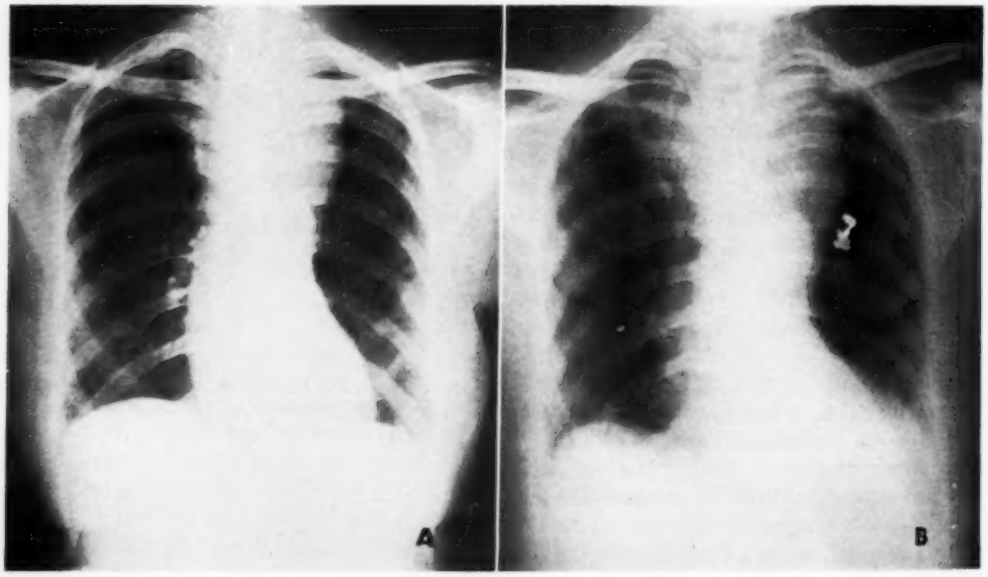


Fig. 8. Retrosternal mass showing rapid enlargement (two months).

roentgenogram shown, her trachea was displaced almost to the angle of the jaw on the right and was drawn down together with all the other normal neck contents, leaving a hard tense neck on which the usual type of positioning was impossible.

A Geiger counter survey (Fig. 9A) showed a trace of activity in the right lobe

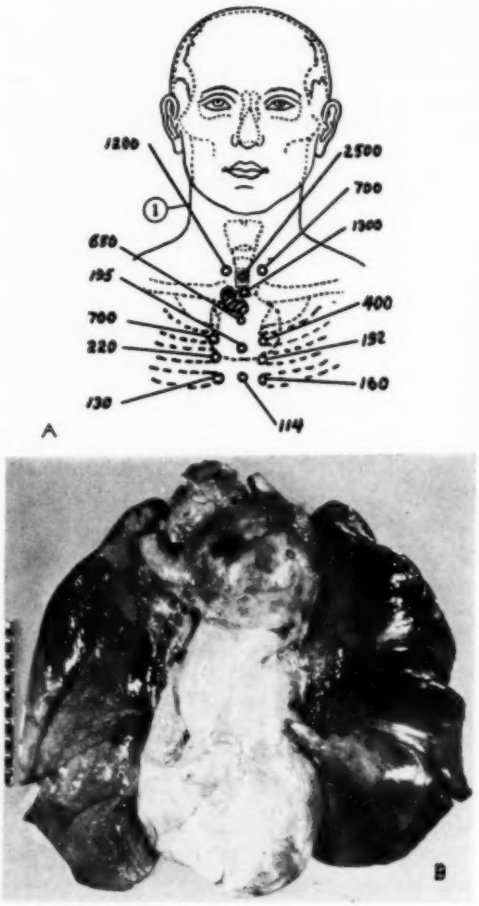


Fig. 9. A. Tracer map. B. Postmortem specimen.

area and nothing in the left lobe region. As in the previous case, one lobe seemed to be completely displaced down behind the manubrium, but below this there was no activity whatever, and no areas of function indicative of the usual islands could be found. There was diffuse scattered activity measurable on the chest wall. When detailed angulated approaches were made with the counter, this activity seemed to be behind the mass rather than in it. Reasoning entirely too much by analogy and relying on the clinical diagnoses, all of which agreed on mediastinal tumor although they disagreed as to origin, we believed this mass to be a thyroid cyst.

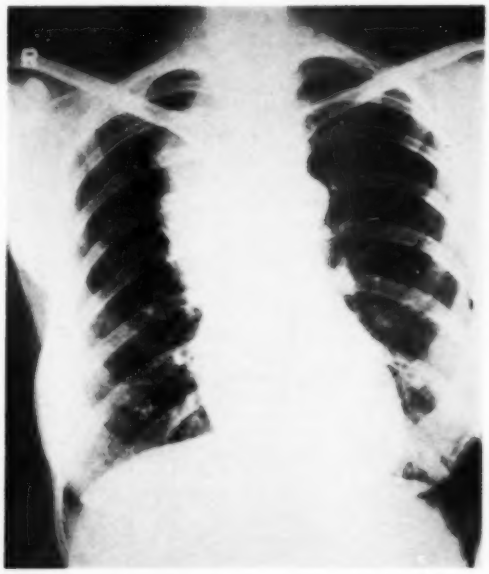


Fig. 10. Retrosternal mass.

The patient declined rapidly into a terminal state of respiratory collapse, and a surgeon attempted to relieve her immediate condition. He encountered a massive aneurysm but escaped without disaster and succeeded in doing some decompression.

The patient died several days later; the postmortem specimen is shown in Figure 9B. The trachea is far over to the left in the photograph (the patient's right), and it will be seen that only a tip of the thyroid still protrudes above the mass. The rest of it is mechanically displaced downward behind the aneurysmal sac, exactly in the position that the counter had indicated. Our gadgets told us the absolute truth but the facts that (*1*) the characteristic "islands" (4) were not present and (*2*) that the diffuse radiation did not come from within the mass were not given adequate consideration.

Where a radioiodine tracer on a mediastinal mass is negative, it is our standard procedure to administer 100 μc. of radioactive phosphorus (P^{32}). The radioiodine will clear from the blood stream within forty-eight hours and thereafter, if the

mediastinal shadow is being caused by an actively growing tumor, a good concentration of the P^{32} can be found. Some tumors, particularly those of the lymphoma group, have such an extremely rapid rate of concentration of this isotope that their tracer pattern is almost specific. In the patient[12] whose roentgenogram is shown in Figure 10, the radioactive iodine tracer was negative and the P^{32} gave a complete outline of the mass. The numerical values shown (Fig. 11) are counts over the intercostal spaces, corrected for soft-tissue background and plotted against time, first for the I^{131} and second for the P^{32} tracer. From these data it was very quickly and easily established that this was not a mediastinal thyroid and that it was an active malignant tumor, probably a lymphoma.

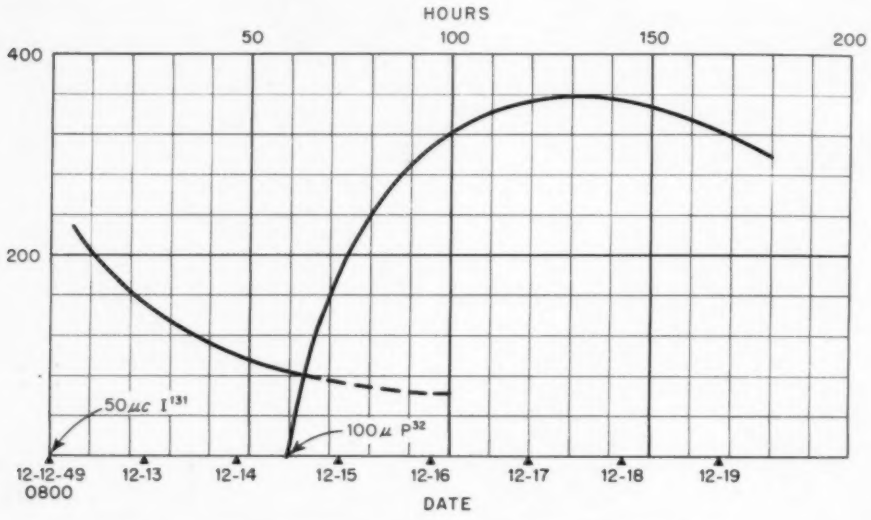


Fig. 11. I^{131} and P^{32} tracer uptake curves of mass shown in Fig. 10.

The patient was given x-ray therapy instead of being subjected to operation, and her physician reports that she is entirely free of symptoms at the end of two full years. During this time interval a node appeared in the supraclavicular region and a biopsy was performed. The diagnosis was lymphosarcoma, confirming the original tracer finding.

[12] See Acknowledgment 10.

In contrast to this case we would like to show one[13] of a mediastinal tumor (Fig. 12A) in which a retromanubrial thyroid was present, was easily demonstrated to the surgeon, and later was visualized at operation. The I^{131} tracer, however, (Fig. 12B) did not outline the larger mass and time was not allowed for a P^{32} tracer. At operation there proved to be two entities, one the retromanubrial thyroid which was not involved in the larger mass, and a gross collection of metastases from a carcinoma of the lung which, when removed, had the appearance of a tangled rope. A radiophosphorus tracer undoubtedly would have warned the surgeon as to what he might have expected to encounter in this case had time been allowed for this procedure.

Radioactive phosphorus to be specific must have time to be metabolized by and incorporated into the cell structure. Any rapid technic involving the use of P^{32} will give too many false localizations on inflammatory states of all sorts and these should be carefully avoided. Specific identifications depend upon a time interval of three to five days, and the initial rate of uptake, provided it is maintained, is a

[13] See Acknowledgment 11.

good index of rate of growth. A retrosternal thyroid, however, is not an unusual condition, at least in the central part of the United States. Many people in apparently perfect health have this condition and it is occasionally discovered entirely by accident on routine chest examination or when some other concomitant condition reveals its presence. The possibility, therefore, of two conditions being present must always be kept in mind. In our entire series 5 patients with retrosternal thyroid had a second condition which was the critical one. Two of these had aneurysms in the presence of a mediastinal thyroid and 3 had neoplasms of other origin. As illustrated, an aneurysm or a tumor of other than thyroid origin may mechanically displace the thyroid into the mediastinum and give a confusing tracer pattern.

Figure 13A illustrates the pitfalls of incomplete technic. This patient with an apparent mediastinal mass was in another city and a quick uptake study rather than a real tracer study was requested as a screening procedure to find out whether or not a complete tracer was indicated. No excretion curve was obtained, and no satisfactory series of counts could be performed. The patient's thyroid did not appear to be entirely normal, and there were some counts found in the right supraclavicular fossa, indicating that the tumor might be a posterior mediastinal thyroid such as we have reported before (3). Arrangements were made to transfer the patient to Harper Hospital for a complete study but instead he went to another institution where at the patient's own insistence surgery was performed without a tracer. The lesion proved to be in the lung, not in the mediastinum, and a tumor not of thyroid origin (Fig. 13B). The case illustrates nothing more than the evils of an incomplete study.

In contrast we can show cases almost identical in appearance (Fig. 14) where correct identification, in this instance[14] a metastatic lesion in the right upper lobe,

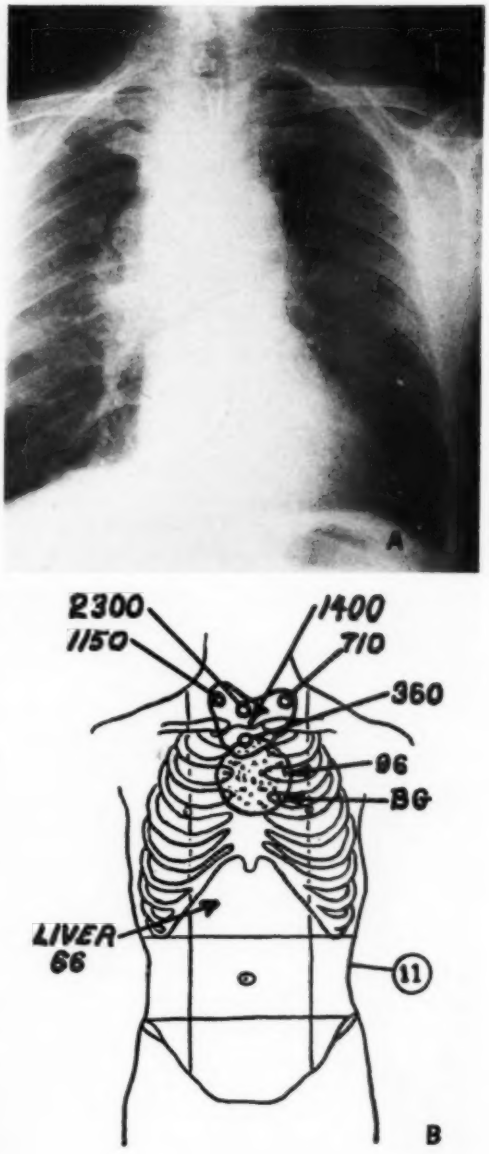


Fig. 12. A and B. Substernal mass proved to be two entities.

was made preoperatively by properly conducted isotope procedure. We expect to publish more details of this and similar studies in the near future.

In this same connection it may be well to point out the inadequacies of any single observation in the evaluation of Graves'

[14] See Acknowledgment 12.

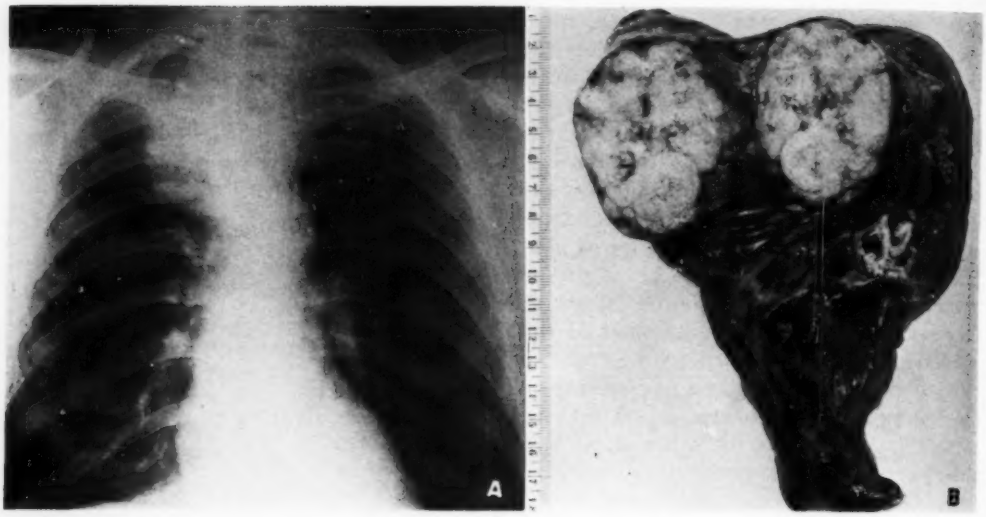


Fig. 13. A and B. Unidentified mass in lung tissue.

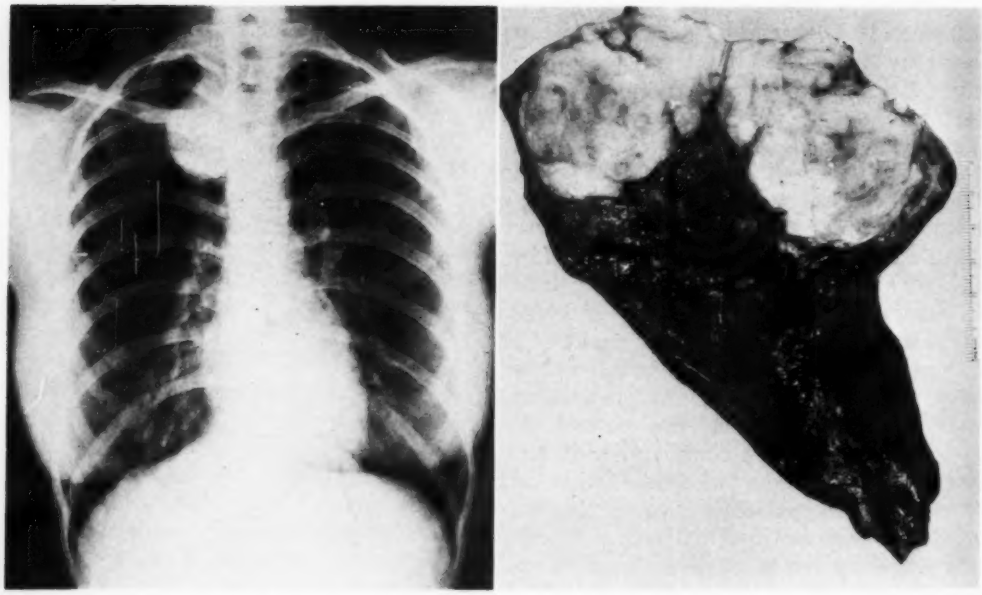


Fig. 14. Metastatic tumor of upper lobe of right lung correctly identified by tracer technic.

disease. As Dr. Earl R. Miller (5) has pointed out many times, Graves' disease remains a clinical diagnosis. If an attempt is made to reach this diagnosis by a single measurement, either of uptake or excretion (or both) of radioiodine, very serious discrepancies can be encountered. The patients whose excretion curves are shown in Figure 15 were all clinically diagnosed as Graves' disease, and all were proved in that they recovered after treatment of their condition by surgery, chemotherapy, or radioiodine. It will be noted, however, that they all show the phenome-

non of "hyperexcretion," throwing away a very large percentage of their tracer dose in a single urine specimen at the very beginning of the study. This phenomenon is not understood and perhaps represents an abnormal renal threshold for halogen ions, but if these people had been measured solely on their total uptake or total excretion they would all have been considered normal or hypothyroids. The phenomenon is not seen in mild cases, and all of the patients shown here were actually clinically very ill.

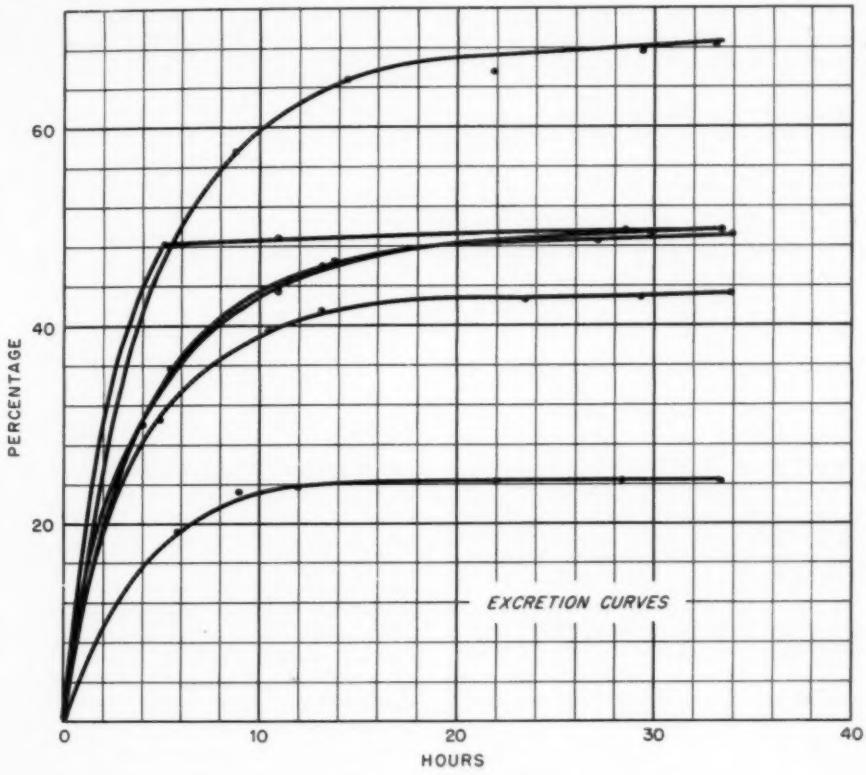


Fig. 15. "Hyperexcreters."

In summary, tracer technic is probably the greatest precision instrument for diagnosis that has been discovered since 1895, but like the x-ray or any other powerful weapon, its potentialities and its limitations must be understood. This physical technology will never supplant sound clinical judgment or expert radiological study. When used carefully in co-operation with the other specialties, its capabilities are almost unlimited.

Since we are presenting the cases on which we did not reach results of which we can be particularly proud, it is essential to point out that in 2,711 tracer studies conducted on 2,367 patients, we have had a total of only 13 failures, flops, and false localizations. The most serious of these were 3 carcinomas of the thyroid which we missed and 3 cases[15] which we believed to be carcinoma of the thyroid that later could not be proved. Four were cases of mediastinal involvement; only 1 of these was an utterly erroneous conclusion, and the other 3 were cases of correct identification

[15] In a fourth originally classified as a failure, metastases developed within six months.

of one of two entities present. In contrast, we have a total of 119 cases of carcinoma of the thyroid identified correctly by tracer technic, 14 of which were *totally unsuspected* at the time tracer study was performed.

ACKNOWLEDGMENT: We wish to express our gratitude to all of the physicians and surgeons who helped to make this work possible. For the cases represented in this paper we are specifically indebted to the following physicians:

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We are indebted to Dr. W. L. Brosius for all of the pathology studies reported.

Harper Hospital
Detroit 1, Mich.

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DISCUSSION

George C. Henny, M.D. (Philadelphia, Penna.): Most workers, like ourselves, in the field of tracer technics learn of the inaccuracies, the difficulties, and the pitfalls after hours of painstakingly careful measurements. We learn the hard way, by making mistakes and then discovering our errors. It is the laudable purpose of the authors to give examples of their pitfalls and after follow-up examinations by the medical staff members to be able to explain their errors. In this way other workers are forewarned of these pitfalls and thus may be able to avoid them. This, indeed, is well worth while. But the audience to whom this essay is addressed probably will be impressed less by the failures and flops that are illustrated, than they are by the phenomenal accuracy that is reported. This is enough to make one sit up and take notice. The physician, in particular, will be surprised, for it is he more than anyone else who realizes the difficulties of such accurate diagnoses in the clinical and pathological fields, when dealing with human beings.

The physician is sometimes said, by the physicist, to be woefully ignorant in the field of physics. So no wonder he cannot explain this accuracy. It is also true that the physicist is not a trained clinician. At any rate an accuracy of 2,354 absolutely correct diagnoses out of 2,367 patients (99.5 per cent) is an amazing record. The statement that tracer technic is probably the greatest precision instrument of diagnosis that has been discovered since 1895 implies that x-ray diagnosis also is near this range of accuracy. I think that the best roentgenologists would readily admit that the percentage of their true and correct diagnoses is not anywhere near this high.

The question might be asked, when the tracer technic and the clinician agree does that clinch the diagnosis? This is all right regarding localization studies which can absolutely be proved later by the surgeon. But our pathologists tell me that diagnosis of pathological conditions in the thyroid is one of the most difficult and controversial fields in the body. For example, they say that distinction between hyperplasia in the true sense and carcinoma often cannot be made on a morphological basis. If the authors are referring in their statistics only to localizations of enlarged or aberrant thyroids, to thyroid cancer or to thyroid metastases, they should make this clear. The diagnosis of all degrees of hypo- or hyperthyroidism is difficult to analyze statistically because clinically the diagnosis is so difficult. In fact, the tracer technic gives the clinician some additional data and the clinician usually accedes to the scientific measurements in making his final diagnosis. It must be remembered that the authors are among the most expert, with very large experience, and that they work in close cooperation with their clinicians, which is much to their credit. I doubt my own ability to differentiate the several diseases of the thyroid with one-tenth the accuracy shown here. I do think that if detailed mapping of the activity can be

done it will often be a great help in the neck as well as in remote metastases. Evidence is not presented for the dependability of other isotopes in other diagnostic uses except for a brief but provocative mention of P^{32}. We usually hope for more improvements in instruments and technics in this rapidly developing field but in the particular field reported by these authors there is practically no room left for improvement.

L. D. Marinelli, Ph.D. (Chicago, Ill.): I would like to ask Dr. Corrigan whether the secretion of iodine in the intestinal tract has misled him, at least early in the investigation. We were certainly caught several times, and I was wondering whether it has happened to him.

R. R. Newell, M.D. (San Francisco, Calif.): I am also very grateful to Dr. Corrigan for pointing out these pitfalls. Medicine is full of pitfalls and we have a chance to avoid them if we are warned about them.

I am overwhelmed with admiration at his diagnostic perspicacity because I don't think anywhere in the field of radiology do they approach this. This has been developed to a very high art with Dr. Corrigan and his associates.

I think this concerns just one thing, which is the differential diagnosis of thyroid disease by scanning after iodine uptake, and I would like to see Dr. Corrigan change his title so as to show that his flops, and so forth, concern only iodine diagnosis in the thyroid.

I escape a feeling of utter incompetence only because we have not made any such attempt to use thyroid iodine uptake as a differential diagnostic tool before operation. We have limited our work to giving a large test dose before operation, so that we would be prepared to study microscopical distribution of iodine uptake after operation in preparation for possible future iodine therapy in case cancer showed there later. That is, our surgeons have not been asking us to help them with the diagnosis of thyroid cancer, but have proceeded on the clinical presumption. We are apprehensive about the development of cancer in any single lump in the thyroid and so our surgeons are very willing to take the thyroid out just because it has a lump in it, without a differential diagnosis. We have also been using I^{131}, of course, to detect metastases in cases of remote cancer.

I have decided I had better buckle down now and try to learn some of Dr. Corrigan's art. I have been very much interested in the proposition of scanning, searching for spots of I^{131} uptake. If you use a large collimator, you can cover a large area with a few settings, but you will not detect small discontinuities. If you want fine detail, you have to use a small collimator, and then you find the number of settings becomes very large to cover the whole chest, for instance. If you leave any gaps between settings, a small spot of activity can be missed, so you have to make the settings overlap. That means more settings still. Moreover, the counting rate through a small collimator is low, and so each setting has to be lengthened in order to reach a statistically significant number of counts. I had begun to think one would work a long time to survey the patient for radioactive spots. Yet Dr. Corrigan does it in a few minutes.

I suppose he does this not by mechanizing his survey, but by the art of knowing how to move his counter over the neck slowly enough to detect small discontinuities and yet fast enough not to waste time on the broad areas where the counting rate isn't changing.

I had thought that by using a very large crystal we could increase the counting rate and shorten the time of each setting, so as to cover the whole area of the body without using up all day doing it.

I want to say again that I admire very much this art of surveying or mapping the thyroid that Dr. Corrigan has brought to such a high state. I had no idea that it could reach this degree of perfection.

Dr. Corrigan (*closing*): First of all I want to thank Dr. Henny for his scholarly and courteous discussion of our presentation. He was particularly kind in not making capital of the fact that our total tracer studies far exceeded our total number of problem cases. It is not uncommon to encounter a chemical block or a completely unexplainable situation in the early part of any study and have to repeat your work before you can understand it. As to the validity of the statistics, there are a number of clinicians in the room whose patients are included in this report.

Dr. Marinelli's mention of secretion of radioiodine in the intestinal tract is very important. Probably the most spectacular demonstration of this occurs in patients who have ulcer and pylorospasm. They will repeatedly concentrate a high level of the radioactive tracer in the gastric secretion and release it. We have had one patient with a colostomy who collected radioiodine in the blind end of the colon. We showed the kidney blockage problem which is encountered occasionally. Actually these are all very easy to identify, and once they have been recognized should cause no trouble.

As to Dr. Newell's statements, I was not able to go into more detail and stay within my time limit. I tried to show that the general principles set forth here do apply to other tracers. For example, in using a tracer for brain localization, any traumatic area, surgical or otherwise, can cause a considerable amount of difficulty and may make the tracer procedure impractical. This is generally true in the body. Any trauma, par-

ticularly a healing process after surgery, may give a very high concentration of most tracers, especially P^{32}.

As to retention of the tracer in tissue specimens, this is a source of a considerable amount of difficulty. Some forms of carcinoma of the thyroid even though they have a good uptake may have a very poor retention. If a few days time elapses between the administration of the preoperative tracer and the actual surgery, the malignant areas may give no useful concentration for radioautography.

As to Dr. Newell's remarks about a lump in the thyroid, the great advantage of a properly conducted tracer study is that it will often bring to light a situation which is in serious need of correction but is not easily demonstrable by older procedures. Certainly if there is the slightest clinical reason for the surgical removal of a nodule nobody would even think of arguing against it.

As to the detailed description on the blackboard, we first presented this slide years ago and discussed it many times. Our technic for complete survey of the patient takes us six minutes, unless aberrant or metastatic localizations are found, in which event more time is needed for complete outlining and identification of these.

Calibration of Therapeutic X-Ray Generators[1]

THEODORE J. WANG[2]

THE CALIBRATION of a therapeutic x-ray generator involves both physical and clinical considerations. Only the physical aspects will be treated in the present paper. The actual physical calibration process is a relatively simple matter. For reasonable accuracy, however, certain precautions are necessary, some of which may not be immediately obvious. These precautions together with some hints on procedure are indicated here.

The limitations of practical radiologic administration preclude accuracies for applied dosage of better than within 10 or 15 per cent; furthermore, the requirements of satisfactory therapy are generally met by accuracies of this same order. These values then imply that it suffices for the physical factors of a calibration to be accurate to within a few per cent.

It is customary to calibrate an x-ray generator with respect to its output as measured with a cavity ionization chamber in air at designated positions and with the machine operating under specified conditions. The measurement is made in air in accordance with the definition of the roentgen and under the assumption that the walls of the measuring chamber are approximately air equivalent over the range of x-ray energies involved. Among ionization instruments which are employed for this purpose the convenient Victoreen Condenser r-Meter is used so frequently that it has become almost a secondary standard. Unless otherwise specified in this article, any mention of an x-ray ionization instrument will refer to the Victoreen Condenser r-Meter (1).

Any particular Victoreen r-meter consistently reproduces readings on equivalent radiation to within 1 or 2 per cent; however, deviations of ±2 per cent between the readings of two recently calibrated instruments have been observed for measurements on the same radiation.

When measurements are being made with the Victoreen r-meter, it is desirable that the auxiliary unit, *i.e.*, the box containing the electroscope and the charging device, be mounted on a horizontal surface since the electroscope fiber displacement is somewhat dependent upon the position of the instrument.

It is also desirable (but not necessary) to have the auxiliary unit sufficiently shielded from the x-ray beam that a negligible amount of radiation penetrates the lead liner of the case of the auxiliary unit. This can usually be most conveniently accomplished by keeping the auxiliary unit near the x-ray control stand, which is normally at a position close to the x-ray apparatus and yet where the radiation intensity is quite low.

In order to approach "in air" conditions, it is essential to arrange the x-ray tube head so that the emergent beam strikes a minimum number of scattering obstacles. This may require removal of patient tables and other flexible treatment room accessories. If the patient table is an integral part of the machine, the best procedure is to swing the tube head so that the beam is at least clear of the table.

The Victoreen thimble chamber exhibits directional properties, and it is necessary to orient the chamber accordingly in the x-ray beam. The chamber is designed to measure a beam which is perpendicular to the axis of the thimble.

It is important to have the active portion of the chamber completely bathed in the radiation which it is measuring. In the 100-r chamber and in the 250-r chamber, the active cavity volume is at the ex-

[1] Accepted for publication in June 1952.
[2] Physics Department, University of Massachusetts, Amherst, Mass.

treme tip and extends over just a little more than half the length of the thimble. In the 25-r chamber the active volume extends the full length of the thimble. If some part of the cavity volume does not receive any radiation, then this part contributes an error to the indicated reading, since the scale calibration in roentgens (e.s.u. per cubic centimeter) is based on the measured ionization divided by the total cavity volume.

Situations are sometimes encountered where it is desirable to evaluate a beam which is narrower than the active region of the available chamber. Examples are found in the measurement of radiation emanating from a small-diameter cone or through a small opening in a lead shield. There is no really satisfactory method of making such a measurement with the standard Victoreen instrument although several compromise methods are possible. One scheme is to extrapolate the values obtained with successively smaller apertures each of which is still sufficiently broad to permit complete immersion of the ionization chamber cavity in the emergent beam. Another scheme employs an end-on measurement with the thimble chamber inserted longitudinally through the aperture. This is done only if a check with wider apertures shows inappreciable deviation in the response in the two positions. Even then the result is still possibly questionable since the ratio of longitudinal and transverse response is not necessarily the same for both large and small apertures as a consequence of differences in quality, quantity, and angular distribution of radiation emerging through the different sized apertures. A third scheme employs a series of measurements along the axis of the beam at distances from the aperture which are sufficiently remote that with a divergent beam the cavity of the chamber is assuredly immersed in radiation. The sequence of measured values is then extrapolated back to the desired distance.

The problem of making measurements of the radiation emergent through narrow apertures can perhaps best be solved by resorting to the use of very small ionization chambers of the types designed by Sievert and by Farmer.[3]

That the quality of the radiation is of some importance to the measurement is demonstrated, particularly for soft radiation, by a study of F. H. Day (2). This work shows what corrections apply to Victoreen chamber measurements in the range of 10 to 200 kv. x-irradiation.

There are three minor complications in the practical application of Day's results. First of all, Day's indicated multiplication factors necessarily apply strictly only to the particular r-meter chambers which he checked; this item is probably of practical concern only for the softest radiation, where the corrections are quite large. Secondly, the given results are based on x-rays from an exceptionally good constant potential source, a condition which does not exist in most low-kilovoltage clinical installations. Approximate equivalence of any given radiation to that from a particular constant potential source can be achieved by the method of matching absorption curves from the given radiation with those from the appropriate constant potential source (3).[4] An alternative and simpler approach to the determination of constant potential equivalent for a particular machine output is through half-value layer. Table I of Day's article gives corresponding values of half-value and constant potential kilovoltage, covering the range of 10 to 200 kv. for filtrations ranging from 1.5 mm. beryllium plus 100 cm. of air to 6 mm. of aluminum. In any case, depending upon the accuracy desired, one may possibly be obliged to resort to a technic of successive approximations since presumably either the half-value layer or the complete absorption curve is apt to be determined by means

[3] Sievert ionization chambers are available from Gustaf Rose, Norrlandsgatan 5, Stockholm, Sweden. Farmer chambers are available from the Baldwin Instrument Co., Ltd., Dartford, Kent, England; American representative, The Atomic Center, 489 Fifth Avenue, New York 17, N. Y.

[4] Extended constant potential reference curves are currently available through the National Bureau of Standards Radiation Laboratory (Attention: Mr. Frank H. Day).

of the very instrument for which the data are intended to provide compensating corrections.

The third minor complication in applying Day's work concerns the fact that his correction factors are given for a minimum air filtration of 100 cm., whereas much superficial therapy with beryllium window tubes is administered at shorter distances, from 50 cm. down to window contact. With the softest radiation at short distances air absorption is a factor in modifying quality (4); furthermore, it is just for the softest radiation that the correction factor for the Victoreen chamber has its strongest quality dependence.

For grenz radiation the multiplying factors indicated by Day approach values of 200 per cent, and failure to evaluate accurately the required correction could in some cases lead to large dosage errors. The problem of calibration of grenz ray machines is such as to require the use of a strictly air chamber together with corrections for air absorption for any extension to distances other than those for which experimental dose measurements are made (4, 5). No suitable chamber for field measurements on grenz ray machines is commercially available at the present time, although improved chamber designs have been developed by Day and by Braestrup.

At x-ray energies beyond 100 kv. the higher intensity Victoreen chamber units are troubled with penetration of radiation through the stem shield, followed by leakage of current through the insulator of the stem capacitor. This leakage is most noticeable in chambers built within the past few years, which have had to be made with polystyrene because the major supply sources of amber, the Baltic areas, have been inaccessible to American trade. The stem leakage current depends upon the extent of the exposure, and it falls off with time following the exposure. In some instances, appreciable leakage may be observed for several minutes after removal of the chamber from an x-ray beam. Approximate determination of the significance of the stem effect for any particular type of

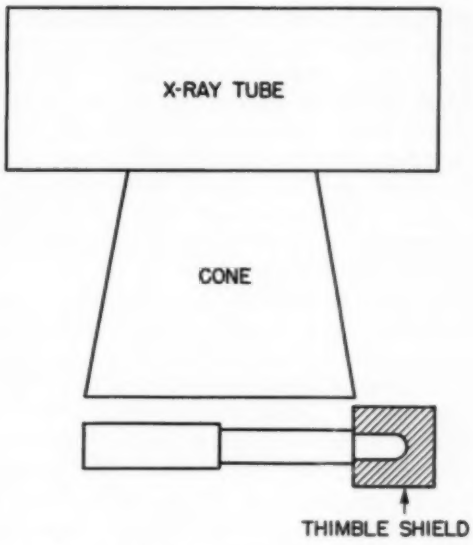

Fig. 1. Set-up for evaluation of stem leakage.

radiation may be made by exposing the stem while shielding the thimble as in Figure 1. Here the thimble is shielded both by a beam-confining cone and by a lead cap so that the major discharge effect is that of insulation leakage. Some slight radiation still reaches the chamber through internal scattering from the stem insulator, and there is a temptation to try to eliminate thimble ionization by removing the thimble, *i.e.*, by unscrewing it from the stem. However, any removal of the thimble risks the possibility of its later restoration with a slightly modified air volume and, consequently, with an uncertainty in the validity of the calibration. But even if the thimble could confidently be restored, there is the more serious problem that with the thimble removed during x-ray exposure there may then be copious ion collection from the air around the stem extremity due to the existence of the electric field between the protruding wire electrode and the rim of the outer cylindrical conductor of the stem.

This latter situation (of ion flow through open air) is somewhat similar to that which would prevail if the standard shielding cap were accidentally omitted from the remote

end of the ionization chamber stem during normal x-ray exposure. The shielding cap contains an insulating plug inside its base which serves to displace the air at the tip of the stem, thus preventing possible ion flow through the air at the back of the stem. This ion flow, if allowed to take place, would be in parallel with that in the main chamber and would therefore introduce an error in the observed result.

It is a tedious operation to charge the Victoreen instrument to a desired electroscope setting because the friction charging is not continuous but occurs in small discrete steps. A saving of time and patience can be effected by utilizing a "vernier" charging arrangement. With this method the instrument is charged to any arbitrary position near the desired setting; then the electrical charge contact switch is released and the charge knob is rotated with the switch disconnected. This will be found to alter the electrical field continuously over a limited region usually sufficient to provide exactly the desired setting.

The scales of the Victoreen electroscope permit easy reading on the 25-unit range where each division represents 1 r or 10 r, corresponding to a full scale of 25 r or of 250 r, respectively. However, on the 100-unit range, which is intended for use with the 100-r chamber, each division represents 2 r; consequently, an observer (who interpolates more naturally in tenth subdivisions than in twentieth subdivisions) occasionally fails to interpolate properly when the image of the fiber falls between scale markings on the 100-unit range. A technic which is sometimes used to circumvent this difficulty is to confine all observations to the 25-unit range and to employ an appropriate multiplier in accordance with the size of the thimble chamber which is being used. Thus, with a 100-r chamber a result of 73.2 would be read not directly from the 100-unit scale but indirectly from the 25-unit scale. The observed reading would be 18.3, and the result would be obtained by multiplication: $18.3 \times 4 = 73.2$.

Perhaps the most frequently abused portion of the instrument is the insulator at the end of the stem remote from the chamber. Every effort should be made to avoid fingering this insulator, because a small amount of oil or dirt from the finger tip may cause excessive surface conduction. Furthermore, it is difficult to adequately clean this insulator once it has been fingered. Many solvents attack polystyrene, causing it to craze. Alcohol on a lintless cloth will help in some cases; in others it may be necessary to replace the whole insulator. In order to protect the insulator surface against possible contamination, it is desirable to keep a cap over the insulator end of the stem whenever the stem is not inserted into the auxiliary unit.

Actually, the thimble end of the stem needs some protection, too, since the thimble is about as fragile as an egg shell. For this reason the thimble might also be protected by a cap whenever there may be any danger of jarring it. Jarring should generally be avoided since it can serve to flake some of the graphite from the interior wall, which in turn yields spurious measurement effects (a chamber with a flaked wall may exhibit abnormal dependence on geometric position).

In many communities the humidity is so high that the drying agent provided with the instrument is inadequate. Under these circumstances it may be found desirable to store the instrument in a desiccator, which may be simply a box with a snug fitting lid and with an additional supply of drying agent. (The Victoreen Co. produces a special desiccator-type carrying case.)

If the instrument is ever found to be spontaneously leaking (due possibly to high humidity), it is easy to determine whether the leak is in the chamber unit or in the auxiliary unit. The auxiliary unit with the stem inserted is charged to full scale. The stem is then removed and kept away from any radiation, and the reading of the electroscope is recorded. This reading of the electroscope may be denoted as the "normal reading." The electroscope fiber assumes a slightly different position with the stem electrically connected to the

auxiliary unit than with the chamber unit removed because the capacitance systems due to the altered geometries are different in the two cases. After a period of about five or ten minutes the electroscope reading is again noted. If it has changed from the normal reading, the auxiliary unit has leaked. With the chamber unit still removed, the electroscope is restored to the normal reading by the process of charging. Then the stem is reinserted into the auxiliary unit. If the electroscope fiber moves now, the indication is that the chamber unit has leaked.

No appreciable leakage can be tolerated in the chamber unit. Frequently, however, a small amount of leakage is acceptable in the auxiliary unit. If the auxiliary unit leaks, then for any actual measurement it is only essential that the normal reading be noted and that the charge be restored to normal just prior to insertion of the stem.

In this connection it may help to protect the stem insulator against accidental fingering to take the normal reading with the stem in position in the auxiliary unit but electrically disconnected by appropriate rotation out of the bayonet lock. This procedure has the added advantage of providing a normal reading which is very near zero. A possible objection to this suggested insertion is that in taking the normal reading following an x-ray exposure, one has to be careful to insert the stem only to the "normal" position, without actually making the electrical connection to the auxiliary unit. Otherwise, if contact is made prematurely, the electroscope may be discharged from a false initial value.

Although checking of the normal reading is advised particularly when leakage has been observed, it is wise to check the normal reading after an x-ray exposure in every case. This precaution safeguards against possible drift of the electroscope during the exposure for any reason, for example, as a result of mechanical jarring.

The Victoreen instrument is very nearly linear in response. In fact, it is sufficiently good in this respect that the National Bureau of Standards has discontinued its practice of calibrating these instruments at several points on the scale. It is worth knowing, however, just what portion of the scale may have been checked in a calibration. In the absence of information to the contrary, it is reasonable to assume that the check has been made in the center of the scale, *i.e.*, at about 15 on the 25-r range. (The scale markings are not linear so that the center of the 25-r range is not at 12.5.)

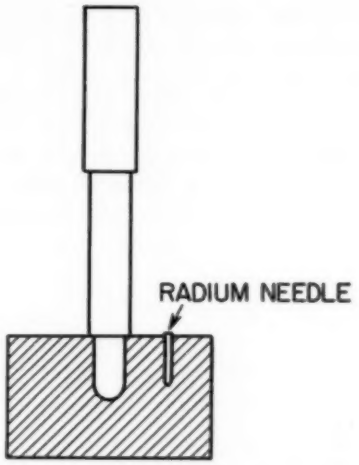

Fig. 2. Exposure arrangement for reliability check on r-meter.

Incidentally, calibration by the National Bureau of Standards includes only a comparison check against a standard air chamber with a report on the required multiplying factor. Calibration by the Victoreen Instrument Co., on the other hand, provides a comparison check against a standard air chamber plus an adjustment of the instrument so that no correction (or, from another point of view, a unity correction factor) is required by the user when the instrument is returned to him.

The person who uses an r-meter can assure both the consistency of the instrument's calibration and extend the periods of the instrument's availability between calibrations by making periodic checks against a radium needle. This is accomplished by drilling two holes in a block of light metal (*e.g.*, aluminum), then mount-

ing an r-meter chamber unit in one of the holes and a radium needle in the other as illustrated in Figure 2. A record is then made of the reading of the r-meter when exposed in this manner immediately after a standardization calibration of the instrument. Any ultimate deviation from this reading suggests that a new calibration should be made on the r-meter. It is important that the holes be accurately drilled in order to minimize the error due to positional displacement of either the chamber or the radium needle. Another hole should be drilled, if necessary, in order to accommodate a second radium needle which can be used alternately with the first needle. Radium needles occasionally leak and change their output, and the use of two independent needles would ensure against an uncertainty due to this cause.

Calibration of the output of an x-ray machine with an r-meter is ordinarily made only at points along an axis perpendicular to the x-ray window on the tube. It is not to be implied, however, that the x-ray beam intensity is either uniform in cross section or symmetrical with respect to a cone axis. In the conventional therapy machine the x-ray beam is taken off the target in a direction normal to the electron beam and, under this arrangement, the intensity pattern in space usually shows a definite heel effect. The maximum intensity may occur just a little off the central axis, and the isodose pattern in a cross-section plane through the x-ray beam may be on the order of that shown in Figure 3. The actual pattern for any particular machine can, of course, be determined by an experimental measure at several points in space.

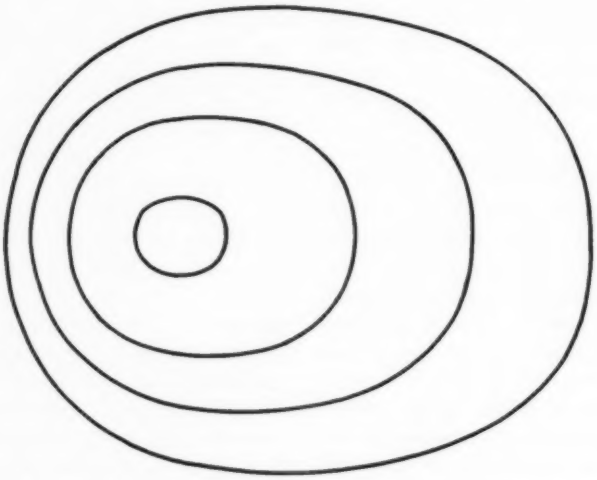

Fig. 3. Isodose pattern in plane through cross section of x-ray beam.

In calibrating an x-ray machine it is frequently convenient to make short runs, about fifteen to thirty seconds duration, in order to stay within the range of an r-meter scale or simply in order to expedite the overall calibration job. These short runs require some discretion in the operation of the timing units. One must ascertain if there is any lag between the initiation of the timing period and the appearance of the full intensity x-ray beam; likewise if there is any lag between the termination of timing and the reduction of the beam to zero intensity. Generally, the stopping of timer and beam can be made simultaneous for all practical purposes and only the starting conditions need to be considered. If the starting lag is reproducible, *i.e.*, if the x-ray output takes just as long to build up each

time the machine is started, then an accurate time-interval can be obtained by utilizing the difference between two indicated times. For example, a machine may yield a measured output I_1 when run for an indicated time t_1 and a measured output I_2 when run for an indicated time t_2. Then if $t_2 > t_1$ and if t_1 exceeds the starting lag, it can be stated with confidence that for the period t_2–t_1 the output is I_2–I_1. Usually the duration of a therapy run is relatively long compared to the starting time-lag, so that in an ordinary therapy run the percentage error due to the time-lag may be negligible. Actual timing in a practical treatment then corresponds fairly well to the precise timing employed in a calibration.

One method of circumventing the time-lag error in calibration consists of using the x-ray shutter, if there is one on the machine being calibrated, for controlling the output both at the beginning and at the end of the exposure, with the timer controlled by the beginning of the shutter motion in each instance. This scheme could introduce some error if the external x-ray intensity rises and falls non-linearly with time as the shutter opens and closes, respectively, but this error would probably be small.

It is well to know the limitations of the commonly employed approximations that the x-ray output is proportional (1) to the square of the inverse distance from the target and (2) to the tube milliamperage. The inverse-square law is not necessarily applicable to x-ray outputs at short distances, say less than 25 cm. from the target, since the target is of finite size and since the radiation suffers some scattering on passage through the tube window and through various diaphragms. A further limitation on the use of the inverse-square law occurs for soft radiation, where attenuation is partly due to decreased density of the beam with increasing radius by virtue of geometry (true inverse-square law effect) and partly due to absorption of energy from the beam by air molecules. The inverse square law, however, is adequate in most cases for making such refinements as are necessary to compensate for inability to

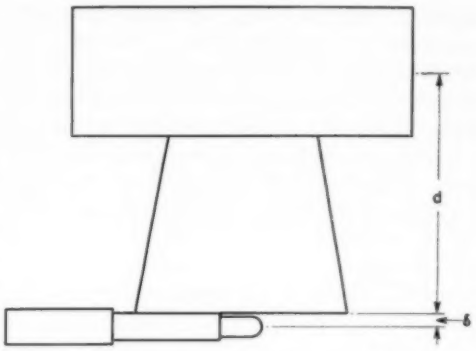

Fig. 4. Positioning error in measurement at rim of cone.

place the axis of the r-meter at the position where a measurement may be wanted, for example, at the rim of a cone (Fig. 4). The significance of a correction for radial displacement depends upon the distance from the target. Thus, if one wishes to know the radiation output at a distance d while the measurement must be made at a distance $d + \delta$, then the relative error involved in using the measured value in place of the wanted value is approximately

$$\frac{\frac{1}{d^2} - \frac{1}{(d+\delta)^2}}{\frac{1}{d^2}} \sim \frac{2\delta}{d}$$

At least two factors may contribute to failure of the measured output to be proportional to the tube milliamperage. One factor is the voltage variation which results from the varied internal drop associated with the different beam currents in the high-voltage circuit. (On some machines this condition is provided for by the use of several scales on the kilovoltage meter corresponding to several currents, or by the use of kilovoltage-meter calibration curves.) Another factor is the alteration of wave shape associated with different currents as a consequence of the action of non-linear circuit elements, namely, tubes and magnetic-core reactances. In general, any deviation of output from linearity with milliamperage is within 10 per cent over the clinical range.

The kilovoltage control is in discrete

steps on certain x-ray machines. On such machines, depending upon the nature of the common load on the power line which feeds the x-ray equipment, it is sometimes impossible to obtain exactly a desired kilovoltage setting. This situation may arise either in calibration or in practice. There are then two ways of determining the ouptut corresponding to a particular kilovoltage. One method is to plot measured values of output *versus* kilovoltage and to interpolate between measured values as required. The other method is to refer to the output as measured at the nearest convenient kilovoltage setting and to introduce a correction factor which is based on a square law response to kilovoltage. Thus, if the indicated kilovoltage during a treatment is 123 kv., and if the nearest calibrated output value is for 120 kv., then the actual output at 123 kv. is given approximately by the value for 120 kv. multiplied by a correction factor of

$$\left(\frac{123}{120}\right)^2 = 1.05.$$

Temperature-pressure corrections for the ionization chamber volume in a calibration may amount to several per cent. There is sometimes a question as to whether these corrections apply to the air conditions at the position of the chamber in the x-ray beam or to the air conditions at the auxiliary unit on the recording stand. These corrections apply to the chamber as it is exposed. To illustrate: if the auxiliary unit is set up in a room adjacent to the x-ray room, it is essential to record the temperature in the x-ray room where the chamber is exposed and not the temperature in the adjacent room where the electroscope observations are made. The pressure differential between the two rooms is ordinarily negligible. Pressure measuring instruments are often unavailable in radiology clinics, but one can obtain pressure values from the local airport—for either sea level or station level—and then correct for the altitude difference to the x-ray equipment at the rate of 1 inch decrease in pressure per thousand feet of altitude increase.

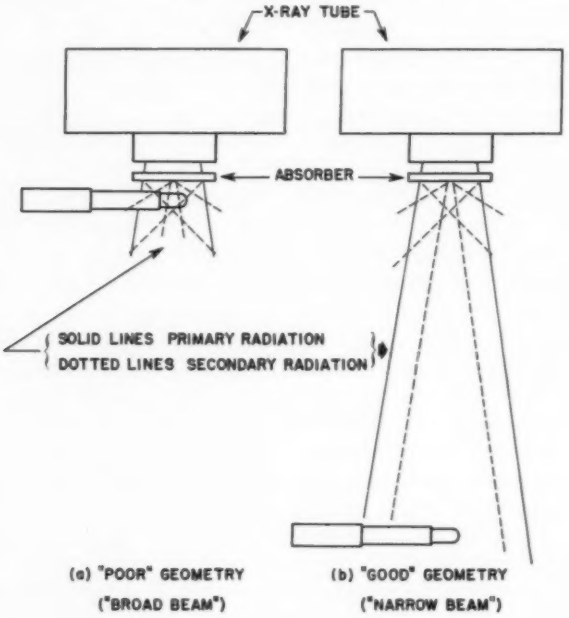

Fig. 5. Geometries for determination of half-value layer.

In using half-value layer as a description of x-ray beam quality it is understood that the half-value layer is that thickness of absorber which reduces the incident beam to half its original intensity. To ensure that the detector measures only the remaining beam to the exclusion (1) of any Compton photons emerging from the absorber and (2) of any energetic secondary electrons which might penetrate into the ionization chamber wall, it is essential to employ what is referred to as "good" or "narrow-beam" geometry. By this is meant simply the location of the chamber far enough away from the absorber to discriminate against scattered entities by the interception of only a limited fraction of the scatter as in Figure 5 (b). The distance between the ionization chamber and the absorber required for good geometry depends upon the quality of the radiation (being greater for increasing kilovoltages), but for the typical therapy installation a separation of about 25 cm. is sufficient.

It should be noted that the Victoreen instrument is unsuited for the calibration of x-ray machines of high instantaneous outputs, above about 1,000 r per minute, even within the first half of the scale where the chamber voltage is high, since, at these high intensities, recombination sets in to preclude complete ion collection within the chamber. Excessively high instantaneous intensities are obtained close to the target with some beryllium window x-ray tubes and with certain pulse-operated machines.

The Victoreen r-meter is frequently used to indicate x-radiation dosage in megavolt ranges. Any such application, however, can be interpreted as providing simply the indicated scale reading of the instrument under the specific circumstances; the measure obtained is not one of roentgens. Actually, no primary standard is known to exist which can provide roentgen measurement of machine-generated x-radiation above about 500 kv. Furthermore, for x-radiation of the order of a few megavolts and above, the roentgen itself is meaningless of definition. For the high energies the most satisfactory approach to dose determination appears to be in the measure of energy absorbed, but toward this end no really satisfactory technic has yet been evolved (6).

The Victoreen carrying case is provided with an exterior handle which is deliberately placed off center in order to be directly above the center of gravity of the instrument to make for stability in carrying. Because the instrument is relatively fragile (and also relatively expensive), cautious individuals prefer to carry the case as a unit under the arm rather than by the handle; if the latches should accidentally fail while the case was being supported by the handle, the instrument almost certainly would fall and be damaged badly.

In carrying the auxiliary unit, one should avoid using the microscope for a handle, for this disturbs the optical system and may ultimately result in stripping the threads on the lead mount into which the microscope screws.

ACKNOWLEDGMENT: I am indebted to the following individuals for their helpful discussions on the subject: Mr. Frank Day, National Bureau of Standards; Messrs. Joseph Stickney and William Managan, Victoreen Instrument Co.; Commanders Jasper Morgan and William Chambers, National Naval Medical Center; Mr. Donald O'Connor, Naval Ordnance Laboratory.

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(Para el sumario en español, véase la página siguiente.)

SUMARIO

Calibración de los Generadores de Rayos X Terapéuticos

Los requisitos físicos para la calibración de los generadores de rayos X son de tal orden que se necesitan ciertan precauciones en aras de la exactitud. Lo acostumbrado es calibrarlos con respecto a su producción, midiendo ésta al aire con una cámara de yonización en posiciones estipuladas y con el aparato funcionando bajo condiciones especificadas. La medición se hace al aire de acuerdo con la definición del roentgen y partiendo de la suposición de que las paredes de la cámara medidora son aproximadamente aero-equivalentes dentro de los límites de las energías de rayos X usadas.

En el trabajo presentado, considérase principalmente el r-metro Victoreen. Se discuten las precauciones que hay que tomar al usar ese r-metro y las posibles causas de error si se usa impropiamente. Se llama la atención sobre el peligro que entrañan los escapes, que pueden afectar muy de veras las lecturas.

En la calibración efectiva, hay que desplegar cuidado para asegurar la exposición uniforme de la cámara. El miliamperaje y el voltaje deben ser constantes. En una calibración, las correcciones de la temperatura-presión para el volumen de la cámara de yonización pueden representar varios por cientos.

El instrumento Victoreen no se presta para la calibración de aparatos de rayos X de alta producción instantánea, de más de 1,000 r por minuto, aun dentro de la primera mitad de la escala en que el voltaje de la cámara es alto. Usase frecuentemente para indicar radiación X en escalas de megavoltios. Sin embargo, toda aplicación de ese género puede interpretarse en el sentido de que ofrece simplemente la lectura indicada en la escala del instrumento en las circunstancias específicas; la medición obtenida no es de roentgens. Para las energías más altas, el método más satisfactorio para la determinación de la dosis parece consistir en la medición de la energía absorbida, pero en ese sentido no se ha elaborado todavía ninguna técnica realmente satisfactoria.

EDITORIAL

Osteitis Condensans Ilii

Osteitis condensans ilii was first described by Sicard, Gally, and Haguenau (7) in 1926. These investigators studied 5 cases but were unable to cast any light upon the etiology. Berent (1), in 1934, stated his belief that the condition usually represents a healed stage of periosteal ligamentary and capsular damage incident to pregnancy. During the ensuing years a number of series of cases have been recorded but the exact cause of this unusual bone lesion is still undetermined.

The characteristic increase in bone density occurring in the ilium, adjacent to the sacroiliac joint, is seen chiefly in women, in most instances in those who have borne children, and this has led many observers to accept Berent's conclusion as to the role of gravidity and labor. This relationship is not universal, however, as a not inconsiderable number of cases have been reported in nulliparae and occasional cases in males. Gillespie and Lloyd-Roberts (2) recently reported a series of 21 cases, all in women who had borne children. They do not believe, however, that multiparity, difficult labor, and puerperal complications predispose toward osteitis condensans. They omit the word ilii in designating the disease because they believe that the lesion is by no means confined to the ilium but affects the sacrum as well.

Symptomatically osteitis condensans is characterized by recurrent attacks of low back pain over a period of months or years. Gillespie and Lloyd-Roberts state that in all of their cases the pain was intermittent, involving the low back or buttocks, or of sciatic distribution. Of 12 patients who had unilateral radiological changes, 6 had pain on the opposite side of the body. These investigators believe that it is doubtful whether this low back pain can be separated clinically from that felt by multiparae without osteitis condensans. In one of their cases, study of a biopsy specimen indicated gradual thickening of bone by the deposition of lamellar bone of normal structure. It was not possible to draw any definite conclusions as to the cause of this increased deposition of bone, but the authors favor a vascular deficiency hypothesis.

Hare and Haggart (3) reported studies of 23 patients with osteitis condensans. In all of their series the changes were limited to the ilium and did not cross the sacroiliac joint. They found nothing suggesting an etiologic factor. Shipp and Haggart (6) later reviewed this same material and extended the series to cover 100 cases. Among those cases seen previous to 1946 they found many which were later classified as Marie-Strümpell arthritis. They felt, therefore, that careful differentiation must be made between these two conditions. All of their patients were adult white females. Seventy-eight of these had borne children, and 48 dated their symptoms from the time of pregnancy. These authors suggest that the condition occurs as the result of mechanical strain affecting an amphiarthrodial joint. They believe that in 6 cases they have demonstrated roentgenographically that the changes may be reversible.

A biopsy study of one case reported by Rendich and Shapiro (5) revealed marked condensation of the osseous tissue with obliteration of the former lacunae. The microscopic changes did not suggest inflammation or neoplastic proliferation.

Knutsson (4) reported a series of 37 cases of which 2 were in men and called attention to the importance of differentiating osteitis

condensans from ankylosing arthritis of the sacroiliac joints. In 5 of his patients sclerotic bone was present in the sacrum as well as in the ilium.

In a recent communication Ude (8) reported more than 30 cases of osteitis condensans ilii with coexisting Scheuermann's disease of the spine. He is convinced that these two lesions are intimately related and that they result from the same antecedent disease, juvenile epiphysitis. He doubts that pregnancy is the etiologic factor because of his discovery of the lesion in several male patients and in one young unmarried female. He concedes, however, that factors associated with pregnancy may be responsible for the more common development of sclerosing osteitis in the female. The epiphysitis, he believes, may not have produced sufficient joint damage to lead to sclerosis, but the latter may develop as a result of the physiologic changes and weight-bearing strain incident to pregnancy. To establish this, it would be necessary to exclude earlier sclerosis.

It is readily seen from this brief review that there is no general agreement as to the etiology of osteitis condensans illi. The increasing number of biopsy studies of these lesions is an encouraging sign of progress, however, even though these have not yet disclosed any characteristic cellular pathology. All such studies have indicated the absence of neoplastic activity or inflammatory reaction. While cases have been reported which were thought to have shown involvement of both the ilium and the sacrum, some of the published illustrations accompanying these reports do not very clearly support this view. It is apparent, also, that the possibilty of ankylosing arthritis, which is prone to occur in this same age group, must be excluded. Such studies as those summarized above cannot fail to be helpful in the ultimate solution of the etiology of this puzzling bone lesion.

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ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN RADIUM SOCIETY

New officers of the American Radium Society for 1953–54 are as follows: President, Edith H. Quimby, Sc.D.; President-Elect, John E. Wirth, M.D.; First Vice-President, H. Dabney Kerr, M.D.; Second Vice-President, Grant H. Beckstrand, M.D.; Secretary, Robert E. Fricke, M.D., Mayo Clinic, Rochester, Minn.; Treasurer, Douglas J. Roberts, M.D.

The next Annual Meeting of the Society will be held at The Homestead, Hot Springs, Va., March 14–16, 1954.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The Fifteenth Annual Mid-Summer Conference of the Rocky Mountain Radiological Society will be held in Denver, Colo., at the Shirley-Savoy Hotel, Aug. 20–22, 1953. An excellent program has been arranged, including the following guest speakers:

DAVID G. PUGH, M.D., Rochester, Minn.
Myelofibrosis and Myelosclerosis
Malacia Disease of Bone

MERRILL C. SOSMAN, M.D., Boston, Mass.
Roentgen Studies in Patients with Mitral Disease
Roentgen Findings in Hemochromatosis

SVEN ROLAND KJELLBERG, M.D., Stockholm, Sweden
Value of Heart Volume Determinations
Urethrocystography in Children

BRIGADIER D. B. MCGRIGOR, London, England
Reminiscences of Forty-four Years of Radiology in the British Army Medical Service
Selected Medical and Surgical Radiological Problems in the Royal Army Medical Corps

FREDERIC E. TEMPLETON, M.D., Seattle, Wash.
Muscular Contraction Patterns in Certain Esophageal Conditions
Gastric Carcinomas, Missed

VINCENT W. ARCHER, M.D., University, Va.
Protection of Radiological Personnel During Diagnostic Procedures

JOHN CAFFEY, M.D., New York, N. Y.
Pulmonary Cysts of Early Infancy: Their Natural Regression
The Skeletal Features of Gargoylism (Dysostosis Multiplex)

Papers will also be presented by the following:

DOUGLASS H. HOWRY, M.D., Denver, Colo.
Visualization of Tumors of Soft-Tissue Structures by the Use of Ultra High-Frequency Sound Waves

R. F. NUESSLE, M.D., Bismarck, N. D.
Tumors of the Small Bowel

LESTER D. SHOOK, M.D., IRA H. LOCKWOOD, M.D., and ARTHUR B. SMITH, M.D., Kansas City, Mo.
Lesions in and about the Second Portion of the Duodenum

HARRY Z. MELLINS, M.D., Detroit, Mich., and LEO G. RIGLER, M.D., Minneapolis, Minn.
Roentgen Findings in Strangulation Obstruction of the Small Bowel

E. DALE TROUT, Sc.D., JOHN P. KELLEY, B.S., and ARTHUR C. LUCAS, Milwaukee, Wis.
Isodose Data for Intracavitary Roentgen Therapy

PAUL C. AEBERSOLD, Oak Ridge, Tenn.
Recent Developments in Atomic Energy of Interest to Radiologists

CHARLES MARTIN, M.D., Dallas, Texas
Carcinoma of the Mouth and Neck

W. WALTER WASSON, M.D., Denver, Colo.
The Life Cycle of the Nasal Accessory Sinuses

ROBERT PARKER ALLEN, M.D., Denver, Colo.
Neurogenic Dysfunction of the Alimentary and Urinary Tracts

EDWARD B. SINGLETON, M.D., Houston, Texas
Obstructive Lesions of the Gastrointestinal Tract in Infants

IRA H. LOCKWOOD, M.D., Kansas City, Mo.
Low Back Pain from Viewpoint of Radiologist

EVERETT L. PIRKEY, M.D., DORIS E. PIPKIN, M.D., and JACK MOSHEIN, M.D., Louisville, Ky.
The Roentgen Manifestations of Early Joint Disease

On Thursday evening, Aug. 20, at a joint meeting with the Denver Medical Society, Dr. Merrill C. Sosman will act as moderator of a Film Reading program, with Dr. Vincent W. Archer, Dr. John Caffey, Dr. Sven Kjellberg, Dr. David G. Pugh, and Dr. Frederic E. Templeton participating. An informal banquet will be held on Friday evening, and the annual picnic at Pine Gables Ranch on Saturday.

SOUTH CAROLINA RADIOLOGICAL SOCIETY

The recently elected officers of the South Carolina Radiological Society are M. E. Parrish, M.D., Sumter, President; Augusta Willis, M.D., Charleston, Vice-President; William A. Klauber, M.D., Self Memorial Hospital, Greenwood, Secretary-Treasurer.

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA

The officers of the Asociación Puertorriqueña de Radiología for the current year are Dr. Carlos Guzmán Acosta, President; Dr. José Landrón, Vice-President and Treasurer; Dr. Rafael A. Blanes, Box 9724, Santurce, P. R., Secretary; Dr. Guillermo Ruiz Cestero, Dr. Lazlo Erlich, and Dr. Jesús Rivera Otero, Directors.

FOURTH BRAZILIAN RADIOLOGICAL CONGRESS

The Fourth Brazilian Radiological Congress will be held in Curitiba, Paraná, Brazil, Sept. 27 to Oct. 3, 1953, under the patronage of the Governor of Paraná, in association with the Centenary of that state. Further information may be obtained from Dr. Roaldo Amundsen Koehler, Secretário Geral, Rua Cândido Lopes, 40-1°, Curitiba, Paraná, Brasil.

JAMES PICKER FOUNDATION AWARDS

Announcement has been made by the James Picker Foundation of grants totaling approximately $40,000 for radiological research. The recipients of new grants are: Drs. Henry Doubilet, M. H. Poppel and J. H. Mulholland, New York University, who will develop a method they have devised of obtaining pictures of the pancreas; Dr. William Meredith, Christie Hospital, Manchester, England, who will investigate the standardization throughout Great Britain and Scotland of x-ray machines used for the treatment of such conditions as cancer; Dr. Bjorn Nordenstrom, Sabbatsberg Hospital, Stockholm, Sweden, engaged in a method for taking improved pictures of blood vessels in the lungs.

The five remaining awards are for the continuation or completion of research projects already in progress under Picker Foundation Awards of prior years. Terminal grants will benefit the following researchers: Dr. Hilda Levi, Zoophysiological Laboratory, Copenhagen, Denmark; Dr. John P. O'Brien, Marquette University, Milwaukee; Dr. Henry P. Plenk, University of Utah, Salt Lake City; Dr. Sidney H. Werner, Columbia University, New York City. A renewal grant was awarded to Dr. William J. Tobin, for research in progress at Georgetown University, Washington, D. C.

For the first time, a full scholarship in radiology was also approved by the Picker Foundation, the recipient being Dr. Walter Whitehouse, presently at the University of Michigan, Ann Arbor.

Applications for the 1954–55 Picker Foundation Awards should be in the hands of the committee, at 70 Broadway, New York City, not later than Nov. 1, 1953.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE ROENTGEN ASPECTS OF THE PAPILLA AND AMPULLA OF VATER. By MAXWELL H. POPPEL, M.D., F.A.C.R., Professor of Radiology, New York University Post-Graduate Medical School, Director of the Roentgen Ray Department, Bellevue Hospital, Consultant in Radiology, Veterans Administration Hospital, Bronx, N. Y., Consulting Radiologist, United States Naval Hospital, St. Albans, Long Island, Roentgenologist, New York University Hospital, HAROLD G. JACOBSON, M.D., F.A.C.R., Director, Department of Roentgenology, Hospital for Special Surgery, Associate Clinical Professor of Radiology, New York University Post-Graduate Medical School, New York, N. Y., Attending in Radiology, U. S. Veterans Administration Hospital, Formerly, Chief, Radiology Service, U. S. Veterans Administration Hospital, Bronx, N. Y., and ROBERT W. SMITH, M.D., Senior Resident in Radiology, Veterans Administration Hospital, Bronx, N. Y. A volume of 196 pages, with 150 illustrations. Published by Charles C Thomas, Springfield, Ill., 1953. Price $8.50.

MORRIS' HUMAN ANATOMY. A COMPLETE SYSTEMATIC TREATISE. Edited by J. PARSONS SCHAEFFER, A.M., M.D., Ph.D., Sc.D., D. Litt., Professor of Anatomy and Director of The Daniel Baugh Institute of Anatomy, Emeritus, The Jefferson Medical College. A volume of 1,718 pages, with 1,220 figures. Published by The Blakiston Co, New York, N. Y. Eleventh edition, 1953. Price $16.00.

TUMORS OF THE THYROID GLAND. Section IV, Fasc. 14, Atlas of Tumor Pathology. By SHIELDS WARREN, M.D., Professor of Pathology, Harvard Medical School, Pathologist, New England Deaconess Hospital, Boston, Mass., and WILLIAM A. MEISSNER, M.D., Assistant Professor of Pathology, Harvard Medical School, Associate Pathologist, New England Deaconess Hospital, Boston, Mass. A monograph of 98 pages, with 82 figures. Published by the Armed Forces Institute of Pathology, under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the National Research Council, Washington, D. C., 1953. For sale by the American Registry of Pathology, Washington 25, D. C. Price $1.75.

TUMORS OF THE MALE SEX ORGANS. Section VIII, Fasc. 31b and 32. By FRANK J. DIXON, M.D., Professor of Pathology, University of Pittsburgh School of Medicine, Pittsburgh, Penna., and ROBERT A. MOORE, M.D., Professor of Pathology, Washington University School of Medicine, St. Louis, Mo. A monograph of 180 pages, with 135 illustrations. Published by the Armed Forces Institute of Pathology, under the auspices of the Subcommittee on Oncology of the Committee on Pathology of the National Research Council. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C., 1952. Price $1.50.

X-RAY & RADIUM THERAPY FOR STUDENTS. By BASIL A. STOLL, F.F.R., D.M.R., (Lond)., D.M.R.T. & D. (Eng.), Late Consultant Senior Radiotherapist, Liverpool Radium Institute. With a Foreword by FRANK ELLIS, M.D., M.Sc., F.F.R. A volume of 206 pages. Published by H. K. Lewis & Co., Ltd., London, 1952. Price 17/6d. net.

X-RAY SIEVE THERAPY IN CANCER. A CONNECTIVE TISSUE PROBLEM. By BENJAMIN JOLLES, M.D., D.M.R., Consultant Radiotherapist, Physician i/c Radiotherapy Department, General Hospital, Northampton; formerly Duchess of Bedford Research Fellow in Medical Radiology, the Middlesex Hospital Medical School, London, etc. With a Foreword by SIDNEY RUSS, C.B.E., D.Sc., F. Inst. P., Professor Emeritus, Middlesex Hospital, Fellow of University College, London. A volume of 192 pages, with 51 illustrations. Published by Little, Brown & Co., Boston, 1953. Price $6.00.

THE PHYSICIAN IN ATOMIC DEFENSE. ATOMIC PRINCIPLES, BIOLOGIC REACTION AND ORGANIZATION FOR MEDICAL DEFENSE. By THAD P. SEARS, M.D., F.A.C.P., Associate Clinical Professor of Medicine, University of Colorado School of Medicine; Chief of Medical Service, Veterans Administration Hospital, Denver; Member of Advisory Staff to Director of Civil Defense, State of Colorado; Member of Disaster Commission, Colorado State Medical Society; Colonel (M.C.), U.S.A.R. With a Foreword by JAMES J. WARING, M.D., M.A.C.P., Professor of Medicine, University of Colorado School of Medicine. A volume of 308 pages, with 53 illustrations. Published by the Year Book Publishers, Inc., Chicago, Ill., 1953. Price $6.00.

Book Reviews

CLINICAL RADIOLOGY OF THE EAR, NOSE AND THROAT. By ERIC SAMUEL, M.D., (Lond.), F.R.C.S. (Eng.), F.F.R. (Lond.), D.M.R.E. (Camb.), Late Hon. Radiologist, the Middlesex Hospital, London; Late Radiologist, Royal National Ear, Nose and Throat Hospital, London; Lieut.-Col. R.A.M.C., Advisor in Radiology to the Army; Sometime Nuffield Foundation Fellow and Duchess of Bedford Research Fellow, the Middlesex Hospital, London. A volume of 340 pages, with 320 illustrations. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York, 1952. Price $13.50.

While a considerable literature on the radiology of the ear, nose, and throat has accumulated in the last two decades, much of it has appeared in journals concerned with the specialties of otology and rhinolaryngology, which seldom come to the attention of the radiologist. Making liberal use of this, as well as of his own observations, the present author has sought to provide a comprehensive coverage of the subject in the compass of a single volume.

The three main sections of the book, as would be expected, deal with (1) the nose and paranasal sinuses, (2) the auditory apparatus, and (3) the larynx and pharynx. Esophageal lesions are purposely omitted. Each section opens with a chapter on radiographic technic, followed by a chapter on the development and anatomy of the structures under consideration, after which the various pathological conditions to be encountered are taken up. In the description of individual lesions consideration is given to the clinical findings as well as to the radiologic aspects. There is also some description of postoperative changes.

The volume is well bound and of attractive appearance. The illustrations are excellent and well chosen. The author has, however, used positive reproductions rather than the original negative form, justifying his choice in this matter by the better contrast and clearer detail thus afforded. An adequate index is included and a list of references follows each chapter.

This book will prove useful not only to radiologists and students of radiology but is recommended also to specialists in the fields covered.

AN ATLAS OF SKULL ROENTGENOGRAMS. By BERNARD S. EPSTEIN, M.D., Associate Radiologist, The Jewish Hospital of Brooklyn, Brooklyn, N. Y., and LEO M. DAVIDOFF, M.D., Neurosurgeon to the Mount Sinai Hospital, New York City, and Director of Neurological Surgery, the Beth Israel Hospital, New York City. A volume of 416 pages, with 603 illustrations. Published by Lea & Febiger, Philadelphia, 1953. Price $15.00.

As the title implies, this is a collection of skull roentgenograms rather than a textbook. An atlas is by definition essentially pictorial, with a minimum of text. Of this the authors make a special point. Accordingly they have confined their descriptive matter to the legends of the illustrations and a few scattered pages setting forth basic considerations. While an occasional laminagram is included, the emphasis is on plain roentgenograms, which have been reproduced without retouching. Pneumoencephalography and cerebral angiography are disregarded, as these have been adequately covered elsewhere.

The authors have chosen their illustrations with the central idea of building up a reference library where all types of skull pathology are demonstrated, and on this basis their work must be judged. The ten chapters deal, respectively, with The Normal Skull; Congenital Variations, Anomalies, and Malformations; Trauma; Infections; Brain Tumors; Gliomas, Primary Sarcomas, and Lipomas; Cranio-

pharyngiomas and Pituitary Adenomas; Miscellaneous Tumors; Tumors of the Vault of the Skull; and Non-Neoplastic Diseases of the Skull. The selection of disease types is excellent, but some of the views are disappointing in their technical aspects and in their reproduction.

The physical make-up of the book is attractive. An index affords ready reference to the contents.

ANGIOQUIMOGRAFIA. ENSAIO DA SUA APLICACAO AO ESTUDO DA HEMODINÂMICA. By DR. AYRES DE SOUSA. Médico-Chefe de Serviço de Radiologia dos Hosp. Civis. A monograph of 250 pages, with 173 illustrations. Published by Livraria Portugalia, Lisboa, 1951.

The author has constructed a roentgenkymograph with central slits running transversely and with peripheral slits on both sides and at the bottom, which run vertically. This permits the simultaneous recording of costal, diaphragmatic, and mediastinal movements. Using this technic he studied the effect of variations in intrathoracic pressure on the blood flow through the lungs and heart. He discusses the kymography of the venous pulse and the significance of variations in venous flow. Using animals he studied what he calls the "segmentation" phenomena in blood vessels, by which he means rhythmic variations in the density of the shadow of opaque material in the vessels. These occur at intervals of approximately 0.07 seconds and are attributed to variations in the dilution of the opaque material.

This publication of more than 200 pages is generously illustrated with reproductions of roentgenkymograms and also with anatomical drawings and other diagrams. It was prepared as part of the requirements for promotion to the associate professorship of radiology of the Faculty of Medicine of Lisbon University. Summaries several pages long in English, French, and German are given. To get the most out of this detailed study, however, it would be necessary to read Portuguese.

SKELETAL RETICULOENDOTHELIOPATHIES. By A. PIAZZA and L. OLIVA. A monograph of 87 pages with 71 roentgenograms and 2 tables. Published by Licinio Capelli, Bologna, Italy.

Eighteen selected observations accurately and completely studied are presented in this monograph to illustrate the various aspects of bone involvement by reticuloendothelial disease. Each case report is accompanied by excellent roentgenograms and includes complete clinical and laboratory data.

The authors review the pathology and the radiological appearance of each condition, describe the effect of roentgen therapy on reticuloendothelial diseases, and attempt to unify our concepts of this interesting but evasive group of conditions. This monograph cannot represent the last word in an unsettled field of pathology, but can be read with profit by all who are interested in this subject.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Robert E. Fricke, M.D., Mayo Clinic, Rochester, Minn.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago 37.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 15 East Monroe, Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Calvin L. Stewart, M.D., 2330 First Ave., San Diego.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Joseph F. Linsman, M.D., 436 N. Roxbury Dr., Beverly Hills. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, Richard C. Ripple, M.D., 1215 28th St., Sacramento. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, C. W. Bruner, M.D., 2456 Fourth Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary*, I. J. Miller, M.D., 2680 Ocean Ave., San Francisco 27. Meets quarterly, at the University Club.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, William H. Graham, M.D., 634 E. Santa Clara St., San Jose 12. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Wm. W. Saunders, M.D., VA Hospital, San Francisco 21. Meets third Thursday at 7:45, Lane Hall, Stanford University Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Wm. S. Curtis, M.D., Boulder Medical Center, Boulder. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, William A. Goodrich, M.D., 85 Jefferson St., Hartford 14. Meets bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, B. Bruce Alicandri, M.D., 20 Maple St., Springfield, Mass. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, U. V. Wilcox, M.D., 915 19th St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, A. Judson Graves, M.D., 2002 Park St., Jacksonville. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, E. Hampton Bryson, M.D., 273 Alhambra Circle, Coral Gables. Meets monthly, third Wednesday, 8:00 P.M., Veterans Administration Bldg., Miami.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Albert A. Rayle, Jr., M.D., 478 Peachtree St. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert M. Tankesley, M.D., 218 Doctors Bldg., Atlanta. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary*, Col. Alexander O. Haff, Tripler Army Hospital, Honolulu. Meets monthly on the third Friday, at Tripler Army Hospital.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, Elbert K. Lewis, M.D., 6337 S. Harvard Ave., Chicago 21. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, John A. Robb, M.D., 23 East Ohio St., Indianapolis. Annual meeting in May.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary*, James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and holds a scientific session in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Willis L. Beller, M.D., 700 Kansas Ave., Topeka. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Hugh Allan Smith, M.D., Eastern Maine General Hospital, Bangor. Meets three times a year—Spring, Summer, and Fall

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, H. Leonard Warres, M.D., 2337 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, John R. Hodgson, M.D., The Mayo Clinic, Rochester. Meets in Spring and Fall.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John W. Evans, M.D., 117 N. President St., Jackson, Miss. Meets monthly, third Tuesday, at 6:30 P.M., at the Rotisserie Restaurant, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Sidney Rubin, M.D., 410 Professional Bldg., Kansas City, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Francis O. Trotter, Jr., M.D., 634 North Grand Blvd., St. Louis 3. Meets on fourth Wednesday, October to May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary*, Grant P. Raitt, M.D., 413 Medical Arts Bldg., Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James F. Kelly, Jr., M.D., 816 Medical Arts Bldg., Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Stanley M. Wyman, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Nicholas G. Demy, M.D., 912 Prospect Ave., Plainfield. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, and October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 8:45 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Joseph J. La Vine, M.D., 259 North Grand Avenue, Baldwin, N. Y. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Harold W. Jacox, M.D., 622 W. 168th St., New York 32.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, A. Gordon Ide, M.D., 277 Alexander St. Meets at Strong Memorial Hospital, 8:15 P.M., last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, Clifford C. Baker, M.D., Harwood Bldg., Scarsdale. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, Waldemar C. A. Sternbergh, M.D., 1400 Scott Ave., Charlotte 2. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, H. Milton Berg, M.D., Quain & Ramstad Clinic, Bismarck. Meets in the Spring with State Medical Association and in the Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Willis S. Peck, M.D., 1838 Parkwood Ave., Toledo 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mortimer Lubert, M.D., Heights Medical Center Bldg., Cleveland Heights 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harry K. Hines, M.D., 2508 Auburn Ave., Cincinnati 19. Meets first Monday of each month, September to June, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, W. S. Koller, M.D., 60 Wyoming St., Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Danstrom, M.D., Medical Arts Bldg., Oklahoma City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Herbert M. Stauffer, M.D., Temple University Hospital, Philadelphia 40. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Donald H. Rice, M.D., West Penn Hospital, Pittsburgh 24. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., 1037 Stuart Bldg., Lincoln, Nebr.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. William A. Klauber, M.D., Self Memorial Hospital, Greenwood. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, Harvey Thompson, M.D., 899 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., Newell Hospital, Chattanooga 2. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, Claude Williams, M.D., Fort Worth. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Building, San Antonio 5, Texas. Meets at Brook Army Medical Center, the first Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Jan. 29–30, 1954, in Dallas.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., 1308 Manteo St., Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John N. Burkey, M.D., 555 Medical-Dental Bldg., Seattle. Meets fourth Monday, September through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. W. Moir, M.D., Sheboygan Memorial Hospital, Sheboygan.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Rafael A. Blanes, M.D., Box 9724 Santurce, Puerto Rico.

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THE HEAD AND NECK

Benign and Malignant Tumors of the Jaws. John B. Erich. S. Clin. North America **32**: 1159–1175, August 1952.

Tumors of the jaws are considered in four groups, a classification which is purportedly helpful in the diagnosis and treatment of these growths. Group 1 consists of intra-oral tumors arising in the soft tissues adjacent to the bones of the jaws. Group 2 consists of cystic tumors arising within the bones of the jaws. Group 3 consists of tumors which originate within the bone and sometimes grow to large proportions and produce a defect filled with some abnormal tissue. Group 4 consists of tumors which roentgenologically produce a moth-eaten appearance of the bone due to malignant destruction.

In the first group the author considers hypertrophic gingivitis, torus palatinus, epulis, and hemangioma, as well as malignant tumors (epithelioma, sarcoma, and adenocarcinoma of the palate). *Hypertrophic gingivitis* is a dental problem, requiring removal of the local irritant. The *epulis* requires surgical excision. The *capillary hemangiomas* are difficult to treat by any method; the cavernous type will respond to interstitial radiation. For the squamous-cell *epitheliomas* Grades 2 and 3, the author recommends a prophylactic cervical node dissection in addition to local treatment, but in Grade 4 he prefers external irradiation of the neck to dissection. Epitheliomas of Grade 1 without any evidence of cervical involvement are not subjected to dissection of the cervical nodes. *Adenocarcinomas* of the palate must be differentiated from *torus palatinus*, which is a congenital piling up of bone along the median raphe of the palate. The former is usually amenable to surgery; the latter seldom needs treatment.

The cystic lesions of Group 2 are of roentgenologic interest. *Root-end* cysts arise in conjunction with granulomas which develop about the roots of teeth that have non-vital and necrotic pulps. They can become large and are not difficult to diagnose because they are associated with a tooth which has a necrotic pulp. If the tooth has been extracted they may be confused with follicular cysts. *Follicular cysts* are of three types, the simple follicular cyst, cystic odontoma, and dentigerous cysts, representing different stages of the same process. The *simple cyst* usually has a definite lining membrane which can be demonstrated roentgenographically; when such a cyst is present one tooth is always absent since the cyst develops from a tooth follicle before any dental structures have formed. In the *cystic odontoma* there is a cystic cavity containing dental tissue, enamel and dentin, in its center or in its wall. The *dentigerous cyst* arises in connection with the embryonic enamel organ, and the cystic cavity always surrounds the crown of a tooth. *Hemorrhagic cysts* follow trauma, and the mechanism is unknown. *Adamantinomas* are malignant tumors arising from the enamel organ of a tooth; they can metastasize to the cervical lymph nodes or even to the mediastinal nodes. They may show simple cystic cavities but usually give a multiloculated appearance in the roentgenogram. Diagnosis is not certain until biopsy.

When roentgen examination reveals a defect in the bone of the jaw filled with some abnormal tissue, then a tumor of Group 3 is present. This group includes fibroma, angioma, giant-cell tumor, solid odontoma, fibrous dysplasia, osteoma, myxochondroma, etc. With the exception of solid odontomas, and perhaps solid osteomas, these various lesions cannot be differentiated roentgenologically. Biopsy is usually necessary. The *giant-cell* tumor usually appears more cystic than solid. The *osteoma* is very dense. *Solid odontomas* contain a conglomeration of dental tissues. The giant-cell tumor should be removed, when small; the odontoma and osteoma may only require removal of that portion of the tumor producing external deformity.

Group 4 includes malignant neoplasms producing a moth-eaten appearance on roentgen examination. The tumor may develop primarily in the bone itself, *e.g.*, a sarcoma; it may be due to an invasion of the bone by an epithelioma in the overlying mucous membrane; it may be secondary in the form of a metastatic tumor. Treatment depends entirely upon the extent and nature of the growth, and on whether or not it is primary or metastatic.

Eighteen roentgenograms; 4 photographs.

JOHN F. RIESSER, M.D.
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La Tomographie de la Base du Crane en Neurochirurgie et Neuro-ophtalmologie (Tomography of the Base of the Skull in Neurosurgery and Neuro-ophthalmology). H. Fischgold, M. David, and P. Brégeat. 138 pages. Masson et Cie, 120 boulevard Saint Germain, Paris, 1952.

The authors of this monograph believe that tomography, or body section roentgenography, is of great value in the study of the base of the skull. The indications for the procedure are discussed in seven chapters: orbit, olfactory region, spheno-orbital region, sella turcica, temporosphenoidal region, basilar apophysis, and the occipitocervical articulation. Each chapter takes up the anatomo-radiologic considerations and radioclinical applications, with the authors' observations in typical cases.

Orbit: In the presence of unilateral exophthalmos there may be a tumor of the orbit, orbital wall, or paranasal sinuses, or there may be an endocranial tumor (or aneurysm). Six cases presented were eventually found to be due to meningioma of the optic nerve, meningioma of the greater and lesser wings of the sphenoid, traumatic carotid-cavernous aneurysm, metastatic hypernephroma, ethmoidal mucocele, and chondroma of the maxillary sinus.

Olfactory Region: Two cases of meningioma of the olfactory groove are reported.

Spheno-orbital Region: The spheno-orbital region is well demonstrated tomographically. Aneurysms of the carotid artery, gliomas of the optic chiasm, low frontal tumors, and meningioma of the lesser wing were found to be more clearly visualized on tomograms than on plain roentgenograms.

Sella Turcica: Observations on patients with pituitary adenoma, craniopharyngioma, chordoma, meningioma of the tuberculum sellae, and sellar alteration produced by intracranial pressure due to astrocytoma of the posterior fossa are presented.

Temporosphenoidal Region: The authors describe cases of hypopressure due to unilateral cerebral atrophy,

plagiocephaly due to early unilateral closure of sutures, hyperpressure due to cerebral hydroma, and aneurysm of the internal carotid which had penetrated the orbit.

Basilar Apophysis: In the region of the clivus the effects of a chordoma may be demonstrated by tomography.

Occipitocervical Articulation: Four cases of basilar impression and 1 of the syndrome of Grisel (anomaly of first vertebra with compensatory cervical scoliosis) are presented.

Preceding the discussion in each chapter, anatomic sections and reproductions of normal radiographic anatomy are given. It should be noted that most of the conditions described may be seen on plain roentgenograms of good quality, but the authors maintain that a better demonstration is realized with the aid of tomography.

One hundred and seven illustrations.

CHARLES M. NICE, M.D.
University of Minnesota

THE CHEST

Examination of the Soft Tissues of the Chest. J. Frimann-Dahl. Acta radiol. **37:** 246–252, March–April 1952.

Pathological changes in the soft tissues of the extremities and flanks have been studied by various authors, but only occasionally have similar investigations been made in lesions of the chest. The author anticipated changes in the soft tissues of the chest wall to be more pronounced in acute inflammatory processes and empyema than in ordinary pleuritis.

A simple technic is described. The patient may be examined in any position—standing, sitting, or supine. The author prefers to make the exposures in the sitting position in the chest-stand subsequent to the conventional examination of the lungs. For comparison the two sides are examined on the same film divided into two. The patients should be placed in a semioblique position with the back against the cassette and rotated 45° forward. The two sides must be turned at the same angle, otherwise the structures will be unequally projected and the one may seem broader and thicker than the other. It may be necessary to make the two exposures in different degrees of obliquity in order to demonstrate the soft tissue at the most suitable angle. In general, the soft tissues corresponding to the dorsal axillary line should be examined. Grids had little influence on the results.

A dense narrow band, the serratus muscle, stretches close to the thoracic wall from the axilla down toward the flank. The lateral contour of this muscle often has a wave-like appearance. Parallel to this and more laterally, a long, band-like, more regular density is observed corresponding to the latissimus dorsi. Between the two muscles is a clear zone, due to a fat layer.

In 35 cases with pleural effusion, mainly of tuberculous origin, no significant findings were recorded. In empyema the positive findings were also few; in some instances edema of the soft tissues was observed. Roentgenograms are reproduced showing a metastatic rib lesion, a subcutaneous abscess, a thoracic tumor, and coarctation of the aorta. The author believes the method may be valuable in differentiating such chest lesions as abscesses, tumors, and empyemas.

Eight roentgenograms.

JOHN R. OLSON, M.D.
Indiana University

A New Bronchographic Technique Employing Aerosol Anesthesia. Further Experiences in Children and Adults. Joseph B. Miller, Norman Dinhoffer, and William H. Conyers, Jr. Am. J. Roentgenol. **68:** 229–239, August 1952.

A technic of bronchography is described which is based on anesthetization of the pharynx, larynx, and tracheobronchial tree by inhalation of a nebulized solution. The solution, available commercially, consists of Pontocaine with glycerin and a detergent added. Glycerin inhibits evaporation of the mist and stabilizes particle size. The detergent, Triton A-20, reduces surface tension of the tiny droplets, thereby causing formation of a thin film of anesthetic solution over the mucosal surfaces. The aerosol technic results in deposition of about 15 per cent of the total amount nebulized, *i.e.*, 1 c.c. of 0.5 per cent Pontocaine, which is a total dose of about 5 milligrams.

Pre-examination medication and instructions are not altered. A piece of adhesive tape is placed over the patient's nostrils so that he is compelled to breathe through the mouth. Eight c.c. of the aerosol solution are placed in a DeVilbiss No. 40 nebulizer. For the first five minutes the patient, pulling his tongue forward, inhales the mist formed by an oxygen flow of 6 liters per minute. The procedure is continued thereafter with oxygen at 10 liters per minute until the entire solution is nebulized. The tape is removed from the nostrils, and the patient positioned for Lipiodol injection. He again holds his tongue completely forward and is cautioned not to cough or swallow. A catheter tip attached to the syringe containing Lipiodol is inserted 2 to 3 inches into the mouth or nostril, with care not to reach the esophagus. Twenty c.c. of Lipiodol are injected rapidly into the pharynx. Control of the Lipiodol stream and filling of the bronchi are achieved by the positioning of the patient.

The authors clearly present step by step the technic employed from premedication to postural drainage following film exposure. Their method has the advantages of simplicity and ease of performance, and increased comfort and safety for the patient.

Twelve roentgenograms; 9 photographs.

DORIS E. PIPKIN, M.D.
University of Louisville

The Protection of the Laryngeal Airway during Swallowing. G. M. Ardran and F. H. Kemp. Brit. J. Radiol. **25:** 406–416, August 1952.

About 500 examinations have been made of swallowing in normal adults, of both sexes, under thirty years of age. In these studies varying consistencies and qualities of barium emulsion were administered. Cineradiographic films were taken at a speed of 25 frames per second on 35 mm. film. The protection of the larynx during swallowing depends upon a number of factors. The epiglottis acts as a ledge to check the descent of the bolus, thereby obviating the necessity for early closure of the larynx. Elevation of the larynx results in the lumen of the laryngeal vestibule being narrowed and arched backward. The bulk of the bolus is normally deviated to one or both sides of the larynx, down the lateral food channels. When the bolus is passing down the lateral food channels, the vestibule may still be open and in communication with air in the hypopharynx. Barium often enters the vestibule at this stage, but only in small quantities and seldom going beyond the false cords. The epiglottis is bent down-

ward to form a hood over the entrance to the larynx, but is not closely applied to the entrance of the larynx until the last of the bolus leaves the pharynx.

Closure of the larynx is effected by contraction of the sphincteric girdle of muscle which surrounds it and can occur without the need for the larynx being raised. The larynx may be closed at any stage during the act of swallowing. Complete closure always takes place when the last of the bolus leaves the pharynx; any barium which has entered the vestibule of the larynx is squeezed out at this stage. As the airway is reopened the epiglottis carries any remaining food upward into the vallecula.

Minor modifications occur, depending upon the behavior of the individual and the size and consistency of the bolus.

In a patient whose epiglottis had been removed for chronic ulceration reinflation of the airway was delayed until all traces of food were removed from the entrance to the larynx by repeated acts of swallowing.

Thirty-one roentgenograms.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Interpretation of Angiopneumographic Images: Distinction between Organic Amputation of the Arteries and Simple Functional Rarefaction of the Pulmonary Circulation. P. Hertzog, R. Israel, L. Toty, and C. Personne. J. franç. de méd. et chir. thorac. **6**: 450–454, 1952. (In French)

Numerous authors have noted displacement of vessels, avascular areas, and so-called amputation of pulmonary arterial trunks caused by tumors of the lung. Attention is called to the fact that the pulmonary blood flow is under relatively low pressure, and inflammatory conditions as well as other functional conditions (such as emphysema) may decrease the available circulation to certain areas involved. At times this results in a short-circuiting of blood to more healthy portions of the lung.

CHARLES M. NICE, M.D.
University of Minnesota

Transitory Lung Infiltrations and Eosinophilia After Therapeutic Oil Injections. W. Löffler, A. F. Essellier, G. de Meyer, and L. Morandi. Schweiz. med. Wchnschr. **82**: 777–785, Aug. 2, 1952. (In German)

Transitory bilateral confluent mottled lung densities were observed on chest radiographs of 2 patients. In each case they followed multiple intramuscular injections of oil, having their onset five to twenty days after the injections were begun, reaching a maximum two weeks later, and completely disappearing one or two weeks after cessation of the injections. Associated with the lung changes was a severe eosinophilia (up to 80 per cent) in the peripheral blood and bone marrow, appearing about ten days after the first injection, becoming maximal a week after the pulmonary manifestations had reached their peak, and subsiding three or four weeks after injections were discontinued.

In the first case (aspiration pneumonia), the injected oil was a vehicle for Penicillin. In the second case (Addison's disease), the oil was non-medicated except in an initial series of injections. The influence of medication was subsequently excluded by deliberately administering three additional courses of oil injections (almond oil, sesame oil, and olive oil) which produced the same syndrome on each occasion.

On the basis of animal experiments by the authors and others which have shown the presence of minute oil emboli in the lungs following parenteral oil injections, the tentative conclusion is drawn that the eosinophilia is caused by the resorption of these "lung infiltrates." The sequence of events and the occurrence of a leukocyte rise speak against allergy as cause.

[These findings are of great importance in view of the frequent use of intramuscular injections of oil-suspended medication in present medical practice. They solve perhaps the riddle presented by a case encountered by the abstracter, in which a large right subhilar lung density was thought to represent a bronchogenic carcinoma. Resection revealed lipoid pneumonia despite the fact that no nose drops had even been given to the patient. There was no clue to the source of the oil. The patient had had one attack of pneumonia a year prior to operation and might well have received intramuscular injections of antibiotics suspended in oil at that time.—G.S.S.]

Eighteen roentgenograms; 2 graphs.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Group Chest X-ray Examinations and the Tuberculosis Death Rate. Philip Enterline. Pub. Health Rep. **67**: 762–766, August 1953.

Fifteen million chest x-ray examinations were done in 1950 in the United States as compared to 6 million in 1946. On the average, about 8.5 per cent of the population of the country had x-ray examinations during each of the years 1947 through 1950. When the number of examinations from 1947 to 1950 are divided into nine geographic groups, there appears to be a definite correlation between the intensity of the case-finding activities and the decline in the death rate from tuberculosis in these regions. Although this correlation is significant at the 1 per cent level, it does not mean that the decline in death rates is attributable to the x-ray activities. Both may be the result of improvement in treatment facilities, living standards, or overall health department activities.

Two charts; 1 table.

D. D. ROSENFELD, M.D.
Fontana, Calif.

Roentgen Examination in Patients with Mitral Stenosis Before and After Valvulotomy. K. F. B. Busch. Acta radiol. **37**: 219–222, March–April, 1952.

This report is based on roentgen examinations made on 22 patients with mitral stenosis during the period from Oct. 4, 1949, to June 19, 1951. Anterposterior kymograms were taken of most of the patients, in addition to ordinary roentgenograms. All measurements were interpreted by the same radiologist.

The findings, which differ somewhat from those classically described in mitral stenosis, are listed as follows: (1) In all but 3 cases the left ventricle was found to be dilated. In 12 patients the right side of the heart was also dilated. (2) The third cardiac curve was found to be dilated in 15 patients. In 19 patients the left atrium projected to the right of the spine. (3) The pulmonary arch on the left side was found to be dilated in 21 patients.

While the size of the pulmonary artery does not seem to be remarkable on the roentgenograms, at surgery it is often found to be greatly enlarged. Rotation of the heart to the left is also a frequent finding at operation.

This explains why left ventricular enlargement is concealed in the anteroposterior view. This enlargement must then be sought for in the second anterior oblique projection. The rotation also displaces the left atrium posteriorly and the only structure seen on the left cardiac border is the left auricle. Thus, the third curve on the left cardiac border in mitral stenosis may be formed by the left auricle and not by the left atrium as is generally assumed.

Valvulotomy was performed on 18 patients, 11 of whom were examined again after the operation. The only change in the cardiac shadow postoperatively was absence of the prominent auricle on the left cardiac border (it had been removed at surgery). The cardiac size was unchanged. The only other new observation was that pulmonary stasis in practically all the operated patients was absent or markedly diminished.

WILLIAM J. LITTLE, M.D.
Indiana University

Roentgen Examination in Coarctation of the Aorta. Fanny Busch. Acta radiol. **37:** 216–218, March–April 1952.

The diagnosis of coarctation has been achieved by various roentgenologic procedures, *e.g.*, by angiocardiography. The author suggests the substitution of planigraphy and kymography for the potentially dangerous intravenous injection of a contrast medium. Three patients who were operated upon for coarctation of the aorta were examined by planigraphy and the site of the stenosis was definitely demonstrated. One of these patients was also studied kymographically, and the results of the previous examination were confirmed.

Two roentgenograms; 1 drawing.

DAVID C. GASTINEAU, M.D.
Indiana University

Interpretation of Prominent Left Middle Arch. Weis, J. Witz, and Cl. Schmidt. J. de radiol. et d'électrol. **33:** 594–596, 1952. (In French)

In the roentgenologic examination of the thorax one often sees a prominent pulmonary arc at the left cardiac border. Among the methods of further study in patients with this condition angiocardiography plays an important role. A prominent pulmonary arc is seen in pulmonary stenosis with poststenotic dilatation; in intrapulmonary hypertension due to mitral stenosis, emphysema, silicosis, etc.; in persistent patent ductus arteriosus, interatrial septal defect, Lutembacher's syndrome, Eisenmenger's complex and in pulmonary arterial aneurysm. In a certain number of cases in which no cause can be ascertained, the phenomenon is described as idiopathic dilatation of the pulmonary artery.

Five roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

Studies on the Mechanism of Ventricular Activity. III. Contraction of the Ventricles in Experimental Bundle Branch Block. L. Allen Smith, Joshua Fields, Rexford Kennamer, and Myron Prinzmetal. Am. Heart J. **44:** 231–237, August 1952.

The authors studied ventricular contractions in 12 dogs, before and after the induction of bundle branch block, by means of simultaneously recorded ventricular lead electrocardiograms and slow-motion cinematographs (500 to 5,000 frames per second) of the beating heart. An analysis of the cinematographs recorded at high speeds and projected at normal speed (16 frames per second) showed that during the control observations, the onset of contraction in both ventricles was almost simultaneous. After the production of bundle branch block the onset of ventricular contraction on the side of the lesion was considerably delayed, being most marked in those animals considered to have complete block and less marked in those having incomplete blocks.

Observations based on an analysis of ventricular motion and simultaneously photographed direct electrocardiographic leads from both ventricles support the conclusion that, in bundle branch block, the mechanical and electrical activities on the side of the lesion experience a similar time delay.

Six cinematographs, with electrocardiographic recordings.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Uncomplicated Isolated Dextrocardia ("Dextroversio Cordis" Type). Howard B. Burchell and David G. Pugh. Am. Heart J. **44:** 196–206, August 1952.

The authors credit Paltauf (Wein. klin. Wchnschr. **14:** 1032, 1901) with the designation "dextroversio cordis" for right-sided hearts in which the chambers are normally arranged. He reserved the term dextrocardia for hearts in which inversion of the cardiac chambers was present. The authors suggest the alternative term "dextrorotation of the heart" for cases which fulfill the following criteria: (1) the great vessels have a normal basic relationship, (2) the heart is normal functionally, and (3) inversion of the cavities is absent.

The present paper is based on 5 selected cases of isolated dextrocardia without inversion of the cardiac chambers and without evidence of cardiac disability. Four of these are presented briefly. During the past fifteen years the authors have seen 7 additional cases of isolated dextrocardia in patients more than ten years of age. Five of these were cyanotic, 3 of them severely so; the aortas of these 3 were clearly on the right, producing a mirror-image heterotopia. Two of the patients with isolated dextrocardia displayed a defect, believed clinically to be an atrial septal defect, which did not produce cyanosis.

Conventional roentgenograms show a reversal of the normal cardiac configuration. The major portion of the cardiac silhouette is within the right hemithorax, and the right border is a mirror-image of the left.

Angiocardiography was performed in 1 of the authors' cases. Angiocardiographic study or cardiac catheterization may be indicated in certain instances to ascertain the position and relationship of the great vessels at the base of the heart or to rule out the presence of an occult interatrial shunt from left to right.

Electrocardiographic tracings in patients with isolated dextrocardia may deviate remarkably little from the normal. Considerable variation was noted among the various cases in the precordial complexes, particularly in those obtained from leads over the left side of the thorax.

The authors emphasize that the diagnosis of dextrocardia does not necessarily imply a functionally abnormal heart. They comment on similar cases recorded in the literature.

Ten roentgenograms; electrocardiograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Boeck's Sarcoid with Unusual Cardiac Configuration and Electrocardiographic Changes. Joshua Rubinstein and Irving G. Kroop. Am. Heart. J. **44:** 313–320, August 1952.

The authors present the case of a 30-year-old man with pulmonary and mediastinal sarcoidosis. The diagnosis was established by biopsy of a node removed from the right supraclavicular region.

Roentgen examination of the chest revealed a diffuse, generalized infiltration throughout both lungs, most marked in the upper lobes. The domes of the diaphragm were elevated and adhered mesially to the pericardium. Considerable emphysema was present, and there was marked hilar adenopathy. The size of the heart was normal, but the shape was peculiarly elongated and globular, as if the heart were rotated into a left oblique position. There was no left atrial enlargement and no prominence of the pulmonary artery segment.

The electrocardiogram showed a regular sinus rhythm, rate 107 per minute, with occasional ventricular premature contractions, right axis deviation. A predominantly tall R was recorded over the left upper quadrant and over the precordium at the level of the sixth intercostal space in positions corresponding to V_4, V_5, V_6, V_7, and V_8. The P waves were prominent in the esophageal, precordial, and standard leads.

Sarcoidosis may involve any portion of the heart and yet produce no clinical symptoms. It may produce disturbances in rhythm and even heart failure. The most frequent secondary cardiac manifestation of sarcoidosis is cor pulmonale caused by pulmonary fibrosis and hypertension.

Four roentgenograms; 3 electrocardiograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Schistosomal Heart Disease: Bilharzic Cor Pulmonale. Harry Vesell and Jerome A. Schack. Am. Heart J. **44:** 296–305, August 1952.

The authors give a detailed case history of a 30-year-old man with schistosomal heart disease and cor pulmonale. The patient lived in the Middle East for twenty years before migrating to the United States. At the age of twenty-two he first noticed hematuria. Subsequently hemoptysis and a chain of symptoms developed. Complete clinical study including angiocardiography led to no specific diagnosis. The clinical diagnoses were paroxysmal hemoglobinuria, amebiasis, renal tuberculosis, chronic glomerulonephritis, cardiac enlargement, valvular heart disease, and hemolytic disease. Even though schistosomiasis was suspected, it could not be proved until after Fuadin therapy, when ova of S. *haematobium* with small terminal spines were found in the urine. The patient died suddenly six months after the authors' first observation. Permission for autopsy was refused.

To the best of the authors' knowledge this is the first report of a case of bilharzial heart disease diagnosed antemortem in this country.

In the recent war large numbers of our armed forces were exposed to schistosomiasis, and many developed the disease. Previously the disease had been almost limited to Egypt, South Africa, Asia, and Japan. A necropsy study in Southern Rhodesia indicated that about 90 per cent of the adult natives of that land had schistosomiasis. In Egypt, 60 to 70 per cent of the inhabitants are infected with Schistosoma.

Schistosomiasis is generally not considered as a cause of cardiac disease. The pulmonocardiac form is common in Egypt but rare in Southern Rhodesia. The lesion causing bilharzic cor pulmonale is an extensive obliterating pulmonary endarteritis due to massive and repeated infection of the lungs with ova. Other types of pulmonary lesions have also been described: (1) a simple perivascular parenchymal tubercle, 250 to 350 microns, developing around two or more ova, and (2) a focal necrotizing arteriolitis, insufficient to cause hypertrophy of the right heart or congestive heart failure. Worms, both dead and alive, have been found in the lungs.

Six roentgenograms; 1 electrocardiogram.

HENRY K. TAYLOR, M.D.
New York, N. Y.

THE DIGESTIVE SYSTEM

A Rare Complication of a Diverticulum of the Thoracic Esophagus. M. Brombart and M. Segers. J. de radiol. et d'électrol. **33:** 541–542, 1952. (In French)

The case is presented of a 75-year-old man who complained of dysphagia upon ingestion of solid foods accompanied by abundant hemorrhage. He also had severe retrosternal pain and regurgitation. Fluoroscopy and roentgenograms revealed a relatively large diverticulum, about 3 cm. in diameter, on the right border of the esophagus at the level of the tracheal bifurcation. Multiple calcified nodes were present in this vicinity, suggesting a traction factor. A niche was demonstrated in the inferior wall of the diverticulum. After three months treatment with liquid diet, sedatives, and antispasmodics, the symptoms were relieved and the niche disappeared.

Five roentgenograms. CHARLES M. NICE, M.D.
University of Minnesota

A Stomach Entirely Thoracic with a Long Esophagus in an Infant of Four Months. A. Jaubert de Beaujeu and R. Didier. J. de radiol. et d'électrol. **33:** 571–577, 1952. (In French)

When the stomach is entirely within the thorax from the time of birth the esophagus is usually short. Thus, the short esophagus has been thought to prevent the normal developmental descent of the esophagus. A four-month-old male was seen with vomiting during and after feeding and with constipation. Nutritional impairment had apparently led to retarded development. Air-fluid levels were present in the base of each hemithorax. After ingestion of barium an esophagus of normal length was demonstrated leading into a transversely placed stomach above the diaphragm. After six hours, considerable stasis was observed in the stomach although the principal portion of the barium had reached the terminal ileum and ascending colon.

Fifteen roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

Esophageal Perforations. A Review of Etiology with Representative Case Presentations. Brit B. Gay, Jr. Am. J. Roentgenol. **68:** 183–197, August 1952.

Perforations and fistulas of the esophagus may be divided into congenital and acquired types. This paper is concerned only with the latter.

In *primary (spontaneous) perforation* of the esophagus,

the essential factor is a sudden increase in intra-abdominal pressure associated with spasm of the pylorus and cricopharyngeus muscles, with resulting increase in the intraluminal pressure of the lower esophagus. This portion of the esophagus is weak and a tear ensues. The stomach contents pass into the mediastinum and left, or rarely the right, pleural space. Subcutaneous emphysema and pleural effusion occur frequently. Cerebral disease is often associated. Perforations have followed vomiting of pregnancy, seasickness, and defecation, and have occurred in the course of gastrointestinal series. The onset is sudden, with acute substernal pain which radiates to the back and shock. Hydro(pneumo)thorax, cervical and/or mediastinal emphysema are salient radiologic features. Mediastinal widening is occasionally seen in later stages but rarely early. A Lipiodol swallow will demonstrate the site of rupture and indicate the relationship to the pleural spaces. No free peritoneal air is found.

Secondary perforation of the esophagus can be due to trauma from within (*e.g.*, from foreign bodies, chemical burns, or instrumentation), to trauma from without, or to disease. Foreign bodies usually perforate at the pharyngo-esophageal junction, posteriorly. On the roentgenogram, air is present in the retropharyngeal or retrotracheal space, and there is prevertebral swelling of soft tissues. The foreign body is visualized if opaque. Roentgenographic signs following perforation due to instrumentation are the same as those in spontaneous perforation and perforation by a foreign body. Crushing injuries to chest and abdomen have been reported with subsequent esophageal perforation. Clinical and roentgen findings are the same as in spontaneous perforations. Neoplasms of the esophagus and occasionally of neighboring organs may cause perforations, but these perforations are usually not acute and pulmonary infection may be the first finding. Inflammatory conditions such as tuberculosis and pyogenic empyema occasionally cause perforation. In a series of 40 cases of peptic ulcer of the esophagus reviewed by the author, 14 per cent perforated with resulting fatality. Perforation of esophageal diverticula has been reported. True aneurysms and dissecting aneurysms may rupture into the esophagus.

The author believes that iodized oil should be used as a contrast medium to avoid irritation if extravasation should occur. He emphasizes that a negative esophagram does not rule out esophageal perforation in the presence of suggestive clinical findings, since the fistulous tract may be difficult or impossible to demonstrate. Only because of increased familiarity with the clinical and roentgen features of esophageal perforation has the mortality rate from this lesion been lowered in recent years.

Fourteen roentgenograms; 2 drawings.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Gastric Ulcer: Benign or Malignant. Dean MacDonald. Canad. M.A.J. **67:** 112–114, August 1952.

The author begins his article with a preamble stating his belief that a benign ulcer does not become malignant and that any malignant ulcer is malignant from the beginning even though clinically benign. The microscopically malignant ulcer may run a benign course for some time, even to the point of healing under medical therapy, before evidence of malignancy is demonstrable macroscopically or roentgenologically. The author therefore feels that it is extremely important to know immediately whether a gastric ulcer is benign or malignant, and not after a period of observation, when it is often too late. Ten to 20 per cent of "sure" benign gastric ulcers were found to be malignant on microscopic study following operation. It is impossible to differentiate between a benign and a malignant lesion clinically, by x-ray examination, or by laboratory procedures, singly or in combination. All gastric ulcers have a real pathological possibility of actually being malignant. Too few people realize that early diagnosis of gastric cancer can be made only by surgical removal of the questionable tissue for histologic examination. Approximately 70 per cent of patients with carcinoma of the stomach already have secondaries when first seen by a physician; 40 to 50 per cent of these have had evidence of digestive dysfunction previously, showing that an opportunity for "early diagnosis" is often missed. The author states that an x-ray diagnosis is rarely, if ever, made of an early gastric carcinoma. Physicians must show that a gastric ulcer is not malignant rather than that it is benign.

Even benign ulcers are potentially dangerous; they can perforate, bleed, produce adhesions and structural changes that are painful and make late surgery difficult. Surgery also provides the best and earliest treatment. The author believes that thoughtfully considered and well carried out surgery involves less danger than the diagnostic waiting period. The incidence of anastomotic ulcer following surgical removal of gastric ulcer is of no clinical significance, so this cannot be an argument against surgical treatment. On the basis of an autopsy study of patients surviving five years following partial gastrectomy for carcinoma, it was concluded that 50 per cent of the number were denied a chance of cure because a wider and more extensive resection had not been performed, *i.e.*, because earlier diagnosis had not been made.

WARREN A. NAFIS, M.D.
Jefferson Medical College

A New Anti-Ulcer Drug: A Clinical and Radiological Evaluation. Max P. Rogers and C. L. Gray. Am. J. Digest. Dis. **19:** 180–185, June 1952.

Clinical data upon the use of a new parasympatholytic agent, Ba-5473, are presented.

Twenty-four patients treated by Ba-5473 had roentgen confirmation of a clinically diagnosed peptic ulcer. Eight more had hypertrophic gastritis without peptic ulcer, and another had duodenal diverticulitis.

Acute symptoms were relieved in every patient within twenty-four to thirty-six hours after beginning therapy. It was not necessary to continue dietary restrictions beyond the initial stage of treatment, if used at all. No significant side-effects were observed after individualization of dosage.

Radiologic evidence of ulcer heading after three weeks therapy was obtained in 19 of the 24 cases. One patient was not checked at three weeks, but was asymptomatic; examination at the end of three months showed that the ulcer had healed. Two patients had not been re-examined at the time of the report. One patient showed reduction of the ulcer crater at three weeks, with complete healing at seven weeks. In another patient examination demonstrated a reduction in the size of the ulcer at three weeks and complete healing in three months.

One patient having duodenal diverticulitis and pain previously uncontrolled by atropine became asympto-

matic during treatment with Ba-5473. Two patients with spastic colitis and 1 with bronchial asthma obtained no relief from the administration of Ba-5473.

Eighteen roentgenograms.

Diagnostic Problems with a Carcinoma of the Stomach. Edwin F. Hirsch and William H. Pfisterer. Illinois M. J. **102:** 132–135, August 1952.

The authors report a case of an unusual carcinoma, apparently arising in the stomach, in a 57-year-old man. One year prior to his final illness a by-passing anastomosis was performed for intestinal obstruction. On his present admission to the hospital the patient complained of diffuse abdominal pain, diarrhea, and flatulence. A smooth mass was felt in the epigastrium and extending to the left costal margin. Fluid removed from the left chest contained vacuolated cells, suggesting a mucinous cancer of the stomach. A scout roentgenogram of the abdomen showed what was considered to be a partial obstruction of the small bowel. A barium meal revealed no lesion of the stomach but did demonstrate a large irregular pocket in the region of the descending duodenum and several fistulous tracts. A barium-enema study demonstrated a fistulous communication between the left side of the transverse colon and the jejunum and a possible gastroenterocolic fistula or a gastrocolic fistula.

Necropsy revealed a cancer on the posterior wall of the stomach which had apparently invaded the retrogastric tissues and eroded the duodenum and head of the pancreas, with fistulous perforation of the transverse colon and stomach. There was thrombosis of the splenic and portal veins and an infarction of the right lobe of the liver.

The roentgenograms provided significant diagnostic information but required the necropsy findings for clarification. The pleural fluid gave suggestive information as to the presence and site of the carcinoma prior to the necropsy.

Three roentgenograms; 3 photographs.

PAUL MASSIK, M.D.
Quincy, Mass.

Relationship Between the Histological Lesions and Radiological Signs of Cancers of the Mucous Membrane of the Stomach (Cancers Localized in the Mucous Membrane and Not Having Spread to the Wall: Stage I). Guy Albot and Jacques Toulet. Am. J. Digest. Dis. **19:** 161–168, June 1952.

The aim of the authors' investigations has not been to exhaust the numerous problems raised by the early diagnosis of gastric cancer, but simply to reveal the anatomical substratum of the initial radiological signs of this cancer. The comparison of the radiological signs and the lesions permits a different anatomical substratum to be assigned to the radiological images according to the degree of evolution.

In the incipient non-ulcerative stage of gastric cancer, the roentgen image does not reveal the cancerous lesion but only the reactional modifications of the submucosa, which greatly exceed in area the often tiny mucous lesion which gave rise to them: sclerosis, contractions of the muscularis mucosae, edematous and inflammatory infiltrations, and functional modifications of the perilesional mucous profile. Their evolution has been followed by the radioclinical method and in the course of the radiotherapeutic test. They are directly influenced by the epitheliomatous transformation of the corresponding mucous membrane as it takes place.

The cancerous mucous membrane can undergo peptic digestion and give rise to ulcerations of variable depths, but the cancer still remains confined to the mucous membrane. According to the extent of peptic digestion, a common niche or a plateau-shaped niche will be seen to appear. Certain ulcerations do not cause a niche, a fact which shows that the functional phenomena and the muscular contractions of the muscularis mucosae continue to play an important role there also.

Two roentgenograms; 2 photographs; 4 photomicrographs.

Tumoral Hypertrophy of the Gastric Mucosa: A Case Report and Summary of Findings. Patrick T. Dolan and Paul H. Sherman. Am. J. Digest. Dis. **19:** 171–175, June 1952.

In the opinion of the authors the terms hypertrophic gastritis and tumoral gastritis are frequently misapplied to a condition of mucosal hypertrophy which they believe to be tumoral and not a reaction to inflammation or injury. Swelling of the mucosal folds with primary or essential inflammatory changes, as would be indicated by the term "hypertrophic gastritis," is a relatively common condition. Enlargement of the folds with hyperplasia and insignificant or secondary inflammatory changes, however, is infrequently reported. *Gastric mucosal hypertrophy* implies a pathologic change which is primarily mucosal overgrowth. Inflammatory changes may or may not be present. In *gastric mucosal polyposis* part or all of the stomach is covered by small grape-like masses. Discrete polyps with independent attachments occur. They may be pedunculated or sessile, and are usually soft. *Hypertrophic gastritis* implies an inflammatory origin of the observed changes. The mucosa is thickened and hyperplastic to the point of production of polypoid formations with defects varying from minute erosions to large discrete ulceration. Diffuse inflammatory changes are present; the muscularis mucosae is markedly hypertrophied.

The authors present 1 case of hypertrophy of the gastric mucosa which seemed "primary" in nature and review 25 additional cases to separate this condition from others with which it is often confused. Gastroscopy was performed in 13 of the cases. In 5 a diagnosis of cancer was made. Hypertrophic folds were observed in 3. In 13 of 25 cases examined, the roentgen diagnosis was carcinoma, in 6 polyps, in 3 tumor, and "lobulated mass," large soft folds, and inconstant filling defect in the remaining cases. Subtotal gastrectomy was performed in 10 cases and a total gastrectomy in 3.

One photograph; 3 drawings.

Roentgenological Findings in Amyloidosis of Stomach. A Case Report. F. C. Shipps and D. D. Brannan. Am. J. Roentgenol. **68:** 204–208, August 1952.

Amyloidosis has been classified pathologically into four groups (Karsner, H. T.: Human Pathology. Philadelphia, J. B. Lippincott Co., 1949). In order of their frequency, they are: (1) *Secondary Amyloidosis*: This is secondary to tuberculosis, suppurative and other chronic diseases. The spleen, kidneys, liver, and suprarenal glands are most frequently involved. (2) *Primary Amyloidosis:* This form shows a predilec-

tion for mesodermal tissues such as skeletal muscles, joints, bones, subcutaneous tissues, smooth muscle of the arteries and gastrointestinal tract, and the heart. (3) *Amyloidosis Associated with Myeloma:* The incidence of amyloidosis in myeloma has been reported as high as 10 per cent. The distribution of the lesions usually follows the primary form. (4) *Amyloid Tumors:* These are localized masses most frequently found in the larynx and in other portions of the respiratory system and in the urinary tract.

The authors report the case of a 48-year-old Negro male with a history of intermittent vomiting and abdominal pain for a decade. Roentgen examination revealed pronounced gastric mucosal folds which were obliterated by peristalsis. On gastroscopy the stomach appeared normal. The patient's course was steadily downhill. At first the clinical diagnosis was chronic pyelonephritis; later this was changed to azotemia of unknown etiology. A marrow biopsy established the diagnosis of plasmacytosis. The Congo Red test positive. The patient died about four months after he was first admitted to the hospital. At autopsy the stomach as well as many other organs showed amyloid infiltration.

Three roentgenograms; 2 photomicrographs.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Concomitant Arterio-Mesenteric Obstruction of the Duodenum and Chronic Oesophagitis. Case Report. Erling Ratjen. Acta radiol. **37:** 369–373, March–April 1952.

The author presents a case in which roentgen examination revealed a megaduodenum with obstruction at the duodenojejunal flexure, stenosing esophagitis, and a small hiatal hernia. This combination of conditions is so unusual that no similar case has been recorded. The patient was a 36-year-old woman, whose symptoms included borborygmi, nausea, vomiting after every meal, dysphagia, and extreme malnutrition. Her health had been normal up to the age of sixteen. At operation the superior mesenteric vessels were found to be enclosed in a thick peritoneal induration which was firmly attached to the duodenojejunal flexure. An isoperistaltic duodenojejunostomy was performed. The patient gained weight following the operation and vomiting ceased. The condition of the esophagus improved somewhat, but the roentgen findings remained essentially unchanged.

Two roentgenograms.

W. L. BRIDGES, M.D.
Indiana University

Multiple Jejunal Diverticula. Kalevi Kettunen. Acta radiol. **37:** 270–274, March–April 1952.

Jejunal diverticula are extremely rare, only 322 cases having been recorded in the literature up to 1948. They are most frequently situated near the ligament of Treitz and diminish distally in size and number. Diverticula of the jejunum are found in all age groups but are most frequently encountered in middle or late adult life. They are nearly always due to mucosal herniation through the muscular layer of the intestinal wall. The author believes that jejunal diverticula produce symptoms much less frequently than do duodenal diverticula, the reason being that the duodenum is fixed and the jejunum relatively free and motile, the constantly changing position of the ostia facilitating the emptying of the diverticula.

Two cases of multiple jejunal diverticula are reported. Both cases were diagnosed roentgenologically. One patient gave a history of diarrhea and the other complained of epigastric pain and vomiting.

Two roentgenograms.

W. L. BRIDGES, M.D.
Indiana University

Intrathoracic Duplications of the Alimentary Tract Communicating with the Small Intestine. James E. Davis and William A. Barnes. Ann. Surg. **136:** 287–295, August 1952.

Instances in which intra-abdominal duplications of the alimentary tract coexisted with intrathoracic anomalies of foregut origin have been reported, and there have been cases of such intrathoracic anomalies of the gut ("gastric cysts" and esophageal duplications) that have extended through the diaphragm to end as blind sacs in the abdomen. In 1950, a related but different type of anomaly was described, *i.e.*, a duplication of a portion of the alimentary tract that communicates with otherwise normal small intestine and that passes through the diaphragm into the chest.

The authors present 1 case in detail and review the findings in 6 other cases.

The ages of these patients varied from two and a half months to five years. Two groups of symptoms were presented. In one group (2 cases) respiratory symptoms and signs (cough, dyspnea, and cyanosis) predominated; these are explained by the presence in the extrapleural space of a large pouch which, distended with gas and fluid, may exert considerable pressure on the lung. In the other group (5 cases) there was evidence of gastrointestinal bleeding (pallor and tarry stools), and there may be pain. In these patients gastric mucosa with ulceration was present in the duplication.

Roentgen examination of the chest in all reported cases showed evidence of a soft-tissue mass, frequently containing air or fluid. This has been variously interpreted as a loop of intestine, a cyst, or tumor. The finding of gas within the thoracic mass suggests either a diaphragmatic hernia or a duplication of intestine; the majority of esophageal duplications, lacking communication with the esophagus, do not contain air.

It should be recognized, however, that a duplication may coexist with a diaphragmatic hernia, and the former may not be evident with loops of barium-filled bowel in the chest. Thus, should the outlined loops of intestine not correspond to the entire mass in the chest, the presence of a duplication should be suspected. The only indisputable differentiating diagnostic measure, though difficult and sometimes impossible to obtain, is a roentgen study using barium, that shows a communication between the thoracic mass and the bowel through a single channel.

All of the 6 cases in which this information was available had developmental anomalies of the lower cervical or upper thoracic vertebrae. Two of the 6 patients presented incomplete rotation of the colon.

Operative intervention is the only rational treatment to eliminate the pain, bleeding, and respiratory distress produced by these anomalies. Gross (Ann. Surg. **131:** 363, 1950. Abst. in Radiology **56:** 300, 1951) concluded that when the symptoms are due entirely to the presence of the mass and its accumulated fluid and gas, excision of the thoracic portion only is necessary. If there is evidence of ulceration (hemorrhage and pain), complete removal of the anomaly is

indicated. Of the total of 7 patients, 2 died in the immediate postoperative period and the remaining 5 have been relieved of symptoms.

Two roentgenograms; 2 photographs; 1 table.

DANIEL WILNER, M.D.
Atlantic City, N. J.

The Capacity of the Large Intestine. Olle Olsson. Acta radiol. **37**: 348–355, March–April 1952.

The anatomy of the large intestine varies widely. Its capacity is of functional significance for it serves both as a reservoir for absorption and as a temporary storage depot of excreta. The capacity of the colon has never been extensively studied. The number of subjects examined or the criteria for filling have been inadequate in the investigations reported.

The capacity of the colon was determined by barium-enema studies in 350 adult patients, all of whom were confined to the hospital. One hundred twenty-one patients had no symptoms referable to the colon; 7 had varying and often only slight constipation, and 51 had transient or persistent diarrhea. All patients with stenosis due to tumor, inflammation, or other pathologic process were excluded from the series.

The usual method of barium-enema examination was employed. The can containing the contrast medium was suspended from a spring balance at a constant level corresponding to an application of pressure of 0.75 m. The contrast medium was of uniform viscosity and specific gravity; the temperature was maintained at 38°. All patients were prepared in the same manner. As soon as the column of barium reached the head of the cecum, the weight was read on the spring scale. It was found that the resistance of the ileocecal valve was so variable that in an occasional case an additional 1,000 c.c. of fluid could be introduced after the cecum was apparently filled before reflux into the ileum took place. The patient was then examined in the erect position to determine if any residual gas was entrapped in the flexures. If feces or an appreciable amount of gas was present, the patient was excluded from the series.

A diagram shows the number of patients and the capacity of the large bowel in the "normal" group, in the constipated group, and in those with diarrhea. Among the normals, the quantity of fluid necessary to fill the colon varied from 0.6 to 3.0 liters. The variations were regarded as statistically insignificant in all groups. It appeared that the capacity of the large intestine was smallest in patients with diarrhea, but this group was so small that no conclusions can be drawn from the study.

Knowledge of the capacity of the large intestine in an individual is of value in the treatment of both functional and organic disorders. Although the series investigated was small, it is hoped that the publication of the paper will stimulate the registration and clinical utilization of information easily obtainable during routine examination of the large intestine.

Two roentgenograms; 2 photographs; 3 charts.

JOHN R. OLSON, M.D.
Indiana University

The Reduction of Intussusception in Children by Barium Enemata. The Radiologic and Clinical Signs Compared. Jens Munck Nordentoft. Acta radiol. **36**: 341–347, March–April 1952.

In Denmark, it is rare for children with intussusception to be subjected to primary operation without a preceding barium-enema study. If reduction is not accomplished by the enema, the child is operated upon—usually without delay. The author believes that proof of success or failure of reduction depends entirely on radiologic evidence and not on clinical signs of improvement. He presents briefly 18 cases from a series of 440 previously reported (Acta radiol. Suppl. 51. Reviewed in Radiology **46**: 416, 1946). All of these 18 cases were operated upon from five hours to about ten days after the barium-enema examination. None of the cases showed conclusive roentgenologic proof of complete reduction of the intussusception. In 15 clinical improvement occurred after the enema. The author concludes that radiologic signs of reduction, *i.e.*, a well filled cecum and distinct ileal reflux, must be unmistakable or surgical measures be immediately taken.

Three roentgenograms.

W. L. BRIDGES, M.D.
Indiana University

Intussusception (Colocolic) with Spontaneous Extrusion of the Intussusceptum. A Case with Unusual Roentgen Manifestations. George Jacobson, Ray A. Carter, and Edward N. Snyder, Jr. Am. J. Roentgenol. **68**: 198–203, August 1952.

Since 1894, only 6 cases of spontaneous elimination of an intussusceptum have been reported. When laparotomy was a more formidable procedure, such an occurrence was not infrequent. In 1893, Leichtenstern collected from the literature 593 cases of intussusception, in 42 per cent of which spontaneous extrusion of the intussusceptum had occurred. In the majority of cases separation took place from the eleventh to the twenty-first day, but in some instances it did not occur for several months.

The authors report the case of a 55-year-old white man who was admitted to the hospital two days after the onset of nausea, vomiting, cramping lower abdominal pain, and bloody stools. The abdomen was distended and tender, but not rigid. Very severe pain developed in the anal region on the day of admission.

No masses or organs were palpable. Peristalsis was infrequent. Temperature was 100° F., pulse 120, respirations 20, and blood pressure 182/120. The urine became grossly bloody on the second hospital day. Blood was also present in the feces, and abdominal paracentesis yielded bloody fluid. The patient had a history of thrombophlebitis involving the vessels of the right leg. In view of the above findings and the history of thrombophlebitis, it was felt that the patient might have a thrombosis of the inferior vena cava, and venography was carried out. On the evidence of this examination it was concluded that a thrombosis of the inferior vena cava was present, extending above the insertion of the renal vein and that surgery was not advisable. He was heparinized.

After subsidence of the abdominal distention, a firm mass could be palpated in the left lower quadrant. A barium-enema study showed an irregular constriction at the rectosigmoid junction, above which the barium entered into what was interpreted as an incompletely filled sigmoid loop and flowed freely into the descending and transverse colons. The "sigmoid loop" was surrounded by a large pocket of air which contained a small amount of barium. This was thought to represent perforation of the bowel, probably due to carcinoma, with a large surrounding air-containing abscess. A transverse colostomy was performed.

Twenty-two days after the onset of symptoms the patient expelled 23 inches of large bowel, all layers of which were necrotic. No evidence of tumor was found.

The previous barium studies were reviewed. What had been interpreted as an abscess surrounding the sigmoid was a colocolic intussusception in which the barium had passed in an uninterrupted column through the intussusceptum, the lumen of which was not completely occluded, and from there into the proximal colon. The air pocket was the dilated lumen of the intussuscipiens into which a small amount of barium had escaped. A reproduction of this very interesting roentgenogram is presented, with an explanatory diagram.

Leichtenstern and others have pointed out that there may be a spontaneous recovery following sequestration of a gangrenous intussusceptum if sufficient time elapses for the serosal surfaces of the entering and ensheathing portions of the intestine to become adherent at the neck of the intussusception so that perforation does not occur. Also, the lumen of the intussusceptum must not become completely obstructed. This incomplete obstruction gave rise to the unusual roentgen features in the present case.

Following the auto-anastomosis, a constriction, which progressed to complete obstruction developed at the site of separation. In addition, the patient performed his own ileosigmoidostomy. When last seen, he was asymptomatic.

Five roentgenograms; 1 drawing; 1 photograph.

DORIS E. PIPKIN, M.D.
University of Louisville

Roentgenological Examination and Evaluation of the Ileocecal Valve. C. L. Hinkel. Am. J. Roentgenol. **68:** 171–182, August 1952.

The ileocecal valve can be identified when barium is introduced into the terminal ileum and graduated pressure is applied to the area.

The appearance of the filling defect at the valve orifice is dependent upon the site of implantation, the size, shape, and thickness of the valve lips, and the degree of prolapse of ileal mucosa. These appearances vary over a wide range in the normal.

Several factors which tend to produce conspicuous defects are presented, together with 2 cases of presumable ileal prolapse, which were surgically explored. The authors feel that preparatory catharsis exaggerates the filling defect produced by ileal prolapse.

Exploration should not be urged in cases of conspicuous ileocecal valve defects of normal size, as the surgical findings are usually minimal or negative. Not all large or peculiarly shaped defects, however, can be differentiated with certainty from tumor of the valve lips. In such cases, as well as in those clinically suspected of tumor, exploration is mandatory.

Fifteen roentgenograms; 4 drawings.

DORIS E. PIPKIN, M.D.
University of Louisville

Volvulus of the Cecum, with Report of Two Cases. David Lea Dean. Ann. Surg. **136:** 319–325, August 1952.

Volvulus constitutes about 10 per cent of all the cases of intestinal obstruction. It occurs most frequently in the sigmoid flexure, less frequently in the cecum and small intestine, and rarely in the stomach or transverse colon. Volvulus of the cecum is considered here to include torsion of the isolated cecum or a torsion of the cecum plus a variable amount of the terminal ileum and the ascending colon.

Torsion of the right colon depends on an abnormal degree of mobility of the cecum and ascending colon. Incomplete fixation after rotation and descent in the development of the colon constitutes an anatomical defect which predisposes to volvulus. Pathological changes rarely begin before 180° torsion, and in many of the cases torsion progresses to 720°. The tightness of the twist rather than the number of turns determines whether the pathologic changes of tissue necrosis will follow. Circulatory changes varying with the degree of vascular occlusion are regularly present. In nearly all cases the venous circulation is disturbed, and there is tremendous passive congestion. This may progress to hemorrhage into the bowel and infarction of its wall, gangrene, and perforation of the twisted segment, with associated peritonitis.

Exact preoperative diagnosis has rarely been made. The usual preoperative diagnosis is that of an acute intestinal obstruction of undetermined cause. McGraw, Kremen, and Rigler (Surgery **24:** 793, 1948. Abst. in Radiology **53:** 605, 1949) state that diagnosis may be made from the simple film of the abdomen by the following findings: (*a*) a dilated cecum in an abnormal position (90 per cent in left upper quadrant), (*b*) loops of small bowel distended with gas often on the right of the cecum, (*c*) the ileocecal valve often on the right of the distended viscus, (*d*) spiral distortion of the mucous membrane folds at the site of the twisting, and (*e*) usually a single fluid level in upright colon. A cone-shaped obstruction of the ascending colon, with spiral mucosal folds seen by barium-enema studies, confirms the diagnosis. Eastman and Adams state that "when in the course of a barium enema the column of barium is unable to pass beyond a certain point distal to the cecum, such as the ascending or transverse colon (organic lesions excluded) so that the cecum itself cannot properly be delineated in its haustral markings by the barium, and when at the same time a large collection of gas appears at the site of the cecum either in the mid-line or slightly to the right of it, this is an indication that volvulus of the cecum has taken place. Rothman, Bruckner, and Zetena (Am. J. Surg. **60:** 292, 1943. Abst. in Radiology **42:** 514, 1944) used a procedure wherein an initial roentgenogram is taken, after which decompression is attempted by Wangensteen suction and enema. A second roentgenogram is taken before operation. If, when the two roentgenograms are superimposed, the gas bubble has not been decreased in size, it points to a closed loop obstruction. By recognizing it as colon by the large fluid level and haustral markings and eliminating sigmoid volvulus, which presents an entirely different roentgen picture, one can hazard an interpretation of volvulus of the cecum.

In differential diagnosis, torsion of the bowel may be mimicked by mesenteric thrombosis, acute pancreatitis, peritonitis, and strangulation of an internal hernia.

Laparotomy is indicated in all cases of volvulus of the cecum. Decompression and allied procedures, which are frequently helpful as primary measures in obstruction of the small bowel, are useful only as adjunct measures, particularly after operation.

The author presents 2 illustrative cases of cecal

volvulus, bringing the total of recorded cases to 313.
Two roentgenograms. DANIEL WILNER, M.D.
Atlantic City, N. J.

Telepaque and Priodax, Gallbladder Media. A Comparative Study. Otto H. Grunow. Texas State J. Med. **48:** 596–600, August 1952.

One hundred and twenty-eight unselected patients were given Telepaque and 61 were given Priodax. A form listing a series of specific side-effects, the results of urinalysis, and the radiographic evaluation was completed for each patient.

Side-effects were found to be significantly less with Telepaque than with Priodax with the exception of flushing. No consistent urinary changes were found in either group.

Telepaque consistently produced more brilliant gallbladder shadows than Priodax. Residual contrast material in the colon, however, was much more common after Telepaque than after Priodax. The author thinks that this can be remedied by decreasing the recommended dosage of Telepaque from 3 to 2 gm., with little or no effect on the density of the shadow in patients of average weight.

Five roentgenograms; 4 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Intra-Abdominal Choledochography. Preliminary Report of a Method of Detecting Stones in the Common Bile Duct. Louis R. Slattery and George M. Saypol. Am. J. Surg. **84:** 229–232, August 1952.

A common duct stone missed surgically presents a problem to both the surgeon and the radiologist. This problem has not been solved satisfactorily as long as unsatisfactory cholangiograms can be blamed for overlooked stones. A common difficulty is blurring due to respiratory motion. This difficulty can be overcome by placing the x-ray film behind the mobilized bile duct within the abdominal cavity, whereupon the film and the bile duct move as a unit with respiration so that respiratory motion does not interfere with the exposure of the film.

The x-ray film is sealed inside a plastic film holder which is sterilized in 1:1,000 Zephiran solution for thirty minutes. Cholecystectomy and exploration of the bile ducts should include mobilization of the duodenum and head of the pancreas after the method of Kocher. After the T-tube has been inserted and the common bile duct sutured, the sterile film holder is slipped into the space beneath the common duct and the mobilized cecum. The water-tightness of the sutured common duct should be checked by saline injection through the T-tube. A self-retaining retractor is inserted to hold the margins of the incision apart, and the tube of a portable x-ray unit is centered over the curve of the duodenum about thirty inches from the surface of the operating table. After 15 to 20 c.c. of 35 per cent Diodrast have been injected, a one and a half second exposure is made, using 60 kv. and 50 ma. No effort is made by the anesthetist to produce temporary apnea. The holder is removed, and immediate development of the film permits the surgeon to know the status of the common duct before closure of the abdomen.

Four roentgenograms; 1 drawing; 1 photograph.

D. DEF. BAUER, M.D.
Coos Bay, Ore.

THE MUSCULOSKELETAL SYSTEM

The Sciatica Problem. Bernard J. Alpers. Canad. M. A. J. **67:** 131–143, August 1952.

By a general review of the history of sciatica it is made clear that efforts to explain all cases by a single cause have invariably failed. While many unaccounted-for cases are the result of a root syndrome, usually associated with disk herniation, the presence of a herniated disk should not be assumed without a careful correlation of the individual history, clinical observations, and myelographic findings. That the myelogram cannot be used alone as a basis for diagnosis is indicated by the occurrence of 10 per cent false positives and 5.3 per cent false negatives in the author's series of 159 cases.

For the greatest possible accuracy in the use of myelograms for the diagnosis of herniated disk it is necessary that the following conditions be fulfilled: (1) the clinical history and findings must be correct for herniated disk; (2) myelography must be performed with a sufficient quantity of contrast medium to insure filling of the lumbosacral sac; (3) the defect must be at the anticipated clinical level, and (4) it must be seen in both anteroposterior and lateral views.

False negatives are often the result of inadequate filling of the lumbosacral sac. In some instances the defect is at a different level than is indicated by the clinical findings and in others it is placed so far laterally or is so slight as to lead to negative or equivocal findings. Rarely the defect is on the side opposite the clinical findings.

False positives are due in part to misinterpretation of the radiological findings but chiefly to lack of proper correlation of the reported defect with all the clinical facts.

Ten tables.

Marie-Strümpell Arthritis (Including a Survey of 41 Cases Treated with X-ray). Charles M. White. J. Kansas M. Soc. **53:** 369–373, August 1952.

This report is based on 41 cases of Marie-Strümpell arthritis seen during the past four years receiving x-ray therapy. Ten cases were classified as early, 27 as moderately advanced, and 4 as far advanced. Three 10 × 20 cm. mid-line spinal ports were used to cover the cervical, thoracic, and lumbar regions, and one 15 × 15 cm. mid-line port to cover the sacral area. Two portals were treated three times a week, each portal receiving 150 r (air) per treatment (quality of irradiation is not stated). About 450 r is thus delivered to each portal in two weeks. If no improvement in symptoms occurred, this series was repeated in six to eight weeks.

An evaluation of results of the x-ray therapy was made based on the subjective response of the patient. Eighty per cent of the patients reported themselves 50 per cent or more improved, which is considered a good result. Remissions have lasted from one to four years in 21 patients. Best results were obtained in early cases.

The authors feel that x-ray therapy is the treatment of choice for Marie-Strümpell arthritis, even though its mode of action is not understood. This should be combined with suitable orthopedic measures. Diagnosis in the early stages is not difficult and is essential if good results are to be obtained.

Six roentgenograms; 1 diagram.

D. D. ROSENFELD, M.D.
Fontana, Calif.

Changes in the Vertebra Caused by Ruptured Intervertebral Discs. Observations on Their Formation and Treatment. Ralph B. Cloward. Am. J. Surg. **84**: 151–161, August 1952.

Six pathological conditions are described as representing roentgenographically distinguishable changes following rupture of an intervertebral disk. They are listed as follows: (1) narrowing of the intervertebral space; (2) narrowing or decrease in the size of the intervertebral foramen; (3) changes in the apophyseal joints (sclerosis, lipping, etc.); (4) subarticular sclerosis of the vertebral bodies; (5) marginal osteophyte or "arthritic" spur formation; (6) malalignment of the vertebrae (and flattening of the lumbar lordotic curve).

The author's operation of vertebral body fusion after removal of the intervertebral disk was originally designed in an attempt to treat all of the above changes resulting from a ruptured disk. The operation has been performed in 262 patients. A complete cure has been obtained in 85 per cent, with restoration of the function of the spine and of the pathologic changes to normal. This study provides a partial answer to the etiology of the various changes.

Fifteen roentgenograms. D. DEF. BAUER, M.D.
Coos Bay, Ore.

Rotational Lordosis: Development of the Single Curve. E. W. Somerville. J. Bone & Joint Surg. **34-B**: 421–427, August 1952.

The hypothesis is presented that the deformity of the spine commonly called structural scoliosis is the result of a series of changes initiated by failure of growth of the posterior elements of a segment of the spine. The shape of the deformity varies with the number of adjoining vertebrae involved. The deformity is a complex one, consisting of lordosis, rotation, and lateral flexion. The initial change is considered to be a failure of growth of the posterior elements of vertebrae, producing a localized lordosis. Theoretically, it would be possible for a localized lordosis of 90° or more to develop. Actually this original deformity is seldom seen, because it is rapidly obscured by compensatory changes in the spine. The spine is flexed forward, and a small kyphos develops above and below the lordosis. Because only a slight degree of flexion is possible without structural change in the vertebrae, the point is soon reached where it is easier for the affected area of the spine to rotate instead. Rotation thus takes place before any marked degree of flexion is apparent. Rotation occurs easily at first but meets with increasing resistance which entails molding of bone. On the other hand, as rotation increases, lateral flexion of the spine itself (forward flexion in relation to the body) meets with less resistance so that a point is reached where resistance to each is the same. From this point on considerable pressure is applied to one side of the vertebrae, depressing growth on that side. They become wedged, with further increase of the deformity.

The author describes an experimental study in which the laminae of several adjacent vertebrae of young rabbits were cauterized at either side of the spinous processes. The ligaments were reinforced by wire loops loosely placed about the spinous processes to prevent separation of the posterior parts of the vertebrae by growth of the bodies. In the 3 rabbits in which the operation was done on four adjacent vertebrae, a curve developed which closely resembles that seen in man, including rotation and deformity of the ribs.

The curve seen in the spine after poliomyelitis is similar to that seen in idiopathic scoliosis but is usually longer, involving more vertebrae. A feature of poliomyelitis is an interference in growth of bones closely associated with paralyzed muscles. In the relevant area of the spine the only part of the vertebrae to which muscles have important attachments are the various parts of the neural arch, and if its growth were disturbed as a result of paralysis of the sacrospinalis muscle a rotational lordosis would result. In the idiopathic deformity it is more likely that a smaller number of vertebrae are involved than in poliomyelitis, resulting in a tighter, shorter, and more vicious-looking deformity.

Fourteen roentgenograms.

RICHARD P. STORRS, M.D.
Syracuse, N. Y.

Hypertrophic Pulmonary Osteoarthropathy Simulating Rheumatoid Arthritis. Subsidence after Pneumonectomy for Carcinoma. Howard A. Frank. New England J. Med. **247**: 283–285, Aug. 21, 1952.

Hypertrophic osteoarthropathy of severe degree is usually associated with pulmonary cancer. This association deserves emphasis in as much as the appearance of arthropathy may antedate the symptoms of the pulmonary lesion by more than a year.

A case is reported in which pulmonary osteoarthropathy was mistaken for rheumatoid arthritis. The inflammatory reaction about the bones and joints was unusually marked. The unsuspected carcinoma of the lung was demonstrated by a chest film taken to investigate atelectasis after laparotomy for perforated duodenal ulcer. Serial roentgenograms demonstrated the rapid progression of the osteoarthropathy before pneumonectomy, and its disappearance within three months of operation. Two separate carcinomas were found in the lung. One was a peripheral adenocarcinoma, while the second was situated at the confluence of the lobes, compressing a major lobar artery. After lobectomy there were steady subsidence of the joint symptoms and notable regression of the periosteal calcification and clubbing.

Osteoarthropathy is commonly mistaken for arthritis, but this mistake will not be made if x-ray examination of the extremities is carried out. Awareness of the common association of hypertrophic osteoarthropathy with malignant thoracic lesions may lead to the discovery of otherwise unrecognized, resectable cancer.

Three roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

The Spinous Apophysis Syndrome. Giovanni Gardella. Ann. di radiol. diag. **24**: 260–274, 1952. (In Italian)

In 1933 Baastrup (Acta radiol. **14**: 52, 1933) reported several cases of "kissing" spinous processes with painful manifestations. Gardella adds 4 new cases in which, due to increased lordosis of the cervical or lumbar segments, to osteoporotic flattening of the vertebral bodies, or to narrowed intervertebral disks, the spinous processes were so close as to rub together and form a new joint. All of the patients complained of localized pain. The pain was relieved by novocain infiltration of the affected area, by diathermy, and by roentgen therapy. The author states, however, that when these measures

fail, it may be necessary to perform a surgical excision of one or more of the involved processes.

Nine roentgenograms. CESARE GIANTURCO, M.D.
Urbana, Ill.

Suprasternal Ossicles. A. Nègre. J. radiol. et d'électrol. **33**: 537, 1952. (In French)

A roentgenogram is submitted, an oblique view of the manubrium, which shows two small accessory ossicles just above the manubrium. In addition, two lateral accessory ossicles are present, one on each side of the sternomanubrial junction. Köhler is quoted as noticing the suprasternal ossicles in 1 to 2 per cent of subjects examined in the oblique position. Neither radiologists nor anatomists have reported the frequency of the lateral ossicles.

One roentgenogram. CHARLES M. NICE, M.D.
University of Minnesota

Bone Changes in the Skull in Dystrophia Myotonica. J. E. Caughey. J. Bone & Joint Surg. **34-B**: 343–351, August 1952.

Dystrophia myotonica is an hereditary-familial disorder. When this mutation appears in a family, the individuals involved in the first generation show cataract alone. In subsequent generations, the cataract occurs at an earlier age and is associated with other features of the fully developed disease picture, such as muscle wasting, myotonia, areflexia, and certain endocrinological changes, including gonadal atrophy. The endocrine lesion may be primarily a failure of the androgenic function of the adrenal cortex and of the gonads.

In the author's series of 21 cases with fully developed dystrophia myotonia, 15 were found to have changes in the skull, and these are reported here. Eleven patients showed thickening of the calvarium. Hyperostosis interna occurred in 11. These changes were more marked in the frontal region but occurred in the parietal region also in some. In 8 patients the frontal sinuses were extensive and deep. In 6 there was extensive pneumatization of the sphenoid bone. The pituitary fossa was small in 8 cases, very small in 5, and normal in 1. In 1 case examined postmortem it was enlarged.

Acromegaloid features and the extensive sinuses suggest that overactivity of the anterior pituitary gland occurs at some time in the course of the disorder in spite of the apparent paradox of the small pituitary fossa.

The author concludes that the high incidence of changes in the skull, consisting of thickened calvarium, hyperostosis interna, small to very small pituitary fossa, and extensive sinuses, cannot be coincidental and should be accepted as some of the variable features of dystrophia myotonica.

Five roentgenograms; 3 photographs.
RICHARD P. STORRS, M.D.
Syracuse, N. Y.

Haemophiliac Arthropathy of the Hip. M. E. Winston. J. Bone & Joint Surg. **34-B**: 412–420, August 1952.

The joint changes which occur in the knees, ankles, and elbows of hemophiliacs are well known. It is less well known that the hips can be affected and that rather characteristic changes also occur in the epiphyseal centers of the femoral heads. In the past, studies in hemophiliac arthropathy have been concerned mainly with the acute and late changes. The observations on intra-osseous hemorrhage have been limited mainly to the reports of cyst-like lesions. There is little beyond the statement that changes occur which resemble osteoarthritis and pseudo-coxalgia (Legg-Perthes disease). The present paper draws attention to the importance of intra-osseous hemorrhage in the production of changes in the hip joint in hemophilia and the possibility that the same mechanism may operate in other diseases of the hip.

The cause of the changes commonly seen in hemophiliac arthropathy is considered to be the irritation of the presence of blood under pressure within the joint space. Hyperplasia of the synovial membrane occurs. Pigment and, later, connective tissues are laid down in the subsynovial tissues. Cartilage is eroded at the joint margins, and the central articular cartilage also shows some degeneration. Cavities appear in the bone, presumably due to intra-osseous hemorrhage. Enormous pseudotumors may develop as a result of intra-articular or subperiosteal hemorrhage, and cause varying degrees of bone erosion and destruction.

When hemophiliac arthropathy of the hip appears *before puberty*, the changes in the hip have features similar to those of pseudocoxalgia (Legg-Perthes disease). These changes consist of varying degrees of flattening, irregularity of density, and fragmentation of the capital epiphysis. Similar changes are seen in many conditions where there is interference with the blood supply to this epiphyseal center, including fracture of the femoral neck, slipped epiphysis, and congenital dislocation. The femoral head may be deprived of blood by either direct tearing of the blood vessels or compression of the vascular channels. Study of radiographs and pathological material suggests that intra-epiphyseal hemorrhage is responsible for most of the damage to the epiphysis. The additional trauma of weight bearing completes the collapse of the epiphysis and produces severe deformity. The cystic changes in the epiphysis and the broadening present in the diaphysis may arise from hemorrhage directly in the epiphysis or diaphysis, or from an extension of the hemarthrosis.

Certain differences in appearance indicate that when changes resembling Legg-Perthes disease occur in young hemophiliacs, they are due to the hemophilia and not to unrelated incidental development of Legg-Perthes disease. The cases of hemophiliac arthropathy show more flattening and destruction of the epiphysis and more broadening of the neck of the femur. The patchy irregularity seen in the typical pseudocoxalgia is not seen. No case of hemophiliac arthropathy shows any attempt at reconstitution of the femoral head. The essential difference may be due to difference in location of the hemorrhage. Radiographs in pseudocoxalgia show metaphysial cysts, which could be due to metaphysial hemorrhage, but in hemophiliac arthropathy the cysts and probably hemorrhage are mainly intra-epiphyseal, and the resulting compression of the epiphysis is probably responsible for the more uniform increase in density which occurs in hemophiliac arthropathy.

After puberty the effects of hemophiliac arthropathy are less severe. Hemorrhage into the femoral head produces cyst formation without collapse. Intra-articular hemorrhage may produce irregularity of the articular cartilage with narrowing of the joint space, changes which resemble those seen in any arthritic joint.

It is suggested that intra-osseous hemorrhage may be important in the production of the changes seen in other hip conditions as well as in hemophiliac arthropathy.

Ten roentgenograms. RICHARD P. STORRS, M.D.
Syracuse, N. Y.

Myelosclerotic Anemia. Report of a Case. Poul Bastrup-Madsen. Acta radiol. **37:** 189–195, March-April 1952.

A case of myelosclerotic anemia occurring in a 67-year-old man with splenohepatomegaly is reported. The diagnosis was made on the basis of a normocystic, normochronic anemia with nucleated red cells and myelocytes, hypocellular bone marrow without abnormal cell forms, extramedullary hemopoiesis in the enlarged spleen as determined by splenic puncture, and sclerotic changes in the roentgenograms of the bones.

The literature on myelosclerotic anemia is reviewed briefly, and the differential diagnosis is discussed. The importance of making the correct diagnosis is stressed since such measures as splenectomy or roentgen irradiation, which may interfere with extramedullary hemopoiesis, may hasten death in this condition.

Two roentgenograms. C. R. MCINTIRE, M.D.
Indiana University

Gaucher's Disease in Bone. F. W. T. Davies. J. Bone & Joint Surg. **34-B:** 454–459, August 1952.

A case of Gaucher's disease with bone involvement in a 19-year-old female is reported. Four years after splenectomy for this condition, the patient was found to have multiple areas of bone destruction in the shafts of both femurs. There were also changes in the head of the right femur suggestive of a form of osteochondritis with aseptic necrosis. Under treatment with immobilization and traction, the avascular segment of the right femoral head appeared to become revascularized. Later a pathologic fracture occurred through a cystic area of bone destruction in the proximal portion of the right femoral shaft. This was followed by progressive destruction of the cortex of the shaft below the level of the fracture. Progressive but less rapid changes occurred in the shaft of the left femur. The characteristic flask-like enlargement of the lower end of the femur was not present in this patient. A biopsy from the base of the neck of the femur and upper cystic segment of the shaft showed massive infiltration by Gaucher's cells.

Deep x-ray therapy was administered with rather striking response, especially in the areas of the right femur in which cortical bone destruction had occurred. The estimated tumor dose at the center of the limb was 2,500 r. Treatment for the left femur was begun later, with satisfactory response. Roentgenograms taken six years after bone involvement had been diagnosed and three and a half years after deep x-ray therapy showed cessation of the process of cortical disruption in the right femoral shaft and some evidence of regression of the lesions with bone repair. The head of the right femur had regained a reasonable shape. No new areas of bone involvement developed during this period of observation.

The author concludes that the changes in the right femoral head, as well as those in the shafts, were due to direct infiltration of the bone by Gaucher's cells. He feels that progressive absorption of the avascular fragment of the femoral head could not have occurred if the blood vessels had been infiltrated. It has been commonly accepted that Gaucher's disease is unaffected by deep x-ray therapy. This case suggests that this method of treatment offers some hope of arresting the progressive infiltration and inducing regression of the bone changes.

Thirteen roentgenograms.
RICHARD P. STORRS, M.D.
Syracuse, N. Y.

Changes in the Head of the Femur in Children Suffering from Gaucher's Disease. R. McL. Todd and S. E. Keidan. J. Bone & Joint Surg. **34-B:** 447–453, August 1952.

Two cases are reported of young children with Gaucher's disease in whom changes in the femoral head developed typical of Legg-Perthes disease. The diagnosis was proved in both cases by microscopic study of tissue from the spleen. Similar changes have been recorded in the literature in 17 children under fifteen years of age with Gaucher's disease.

In Gaucher's disease, cells of a characteristic microscopic appearance and containing the lipoid kerasin infiltrate the spleen and liver, giving rise to splenomegaly and hepatomegaly. Hemorrhages are also frequent because of bone marrow infiltration, leading to thrombocytopenia and leukopenia. The roentgen changes most often seen are the "Erlenmeyer flask" appearance at the lower end of the femur, produced by expansion of the bone, destruction of the spongiosa, and pressure atrophy of the cortex. Later, sclerosis of the shaft of the femur may occur. The second most common bone change in Gaucher's disease is that in the proximal end of the femur resembling Legg-Perthes disease. When Gaucher's cells infiltrate the shaft of a bone, radiolucent areas result. Although similar areas occur in the neck of the femur, the head usually shows an increased density. This appearance cannot be explained by multiplication of Gaucher cells in the bone. Similar changes occur in conditions which interfere with the arterial supply to the bone and produce aseptic necrosis. Gaucher cells have been found in the adventitia of small arterioles on microscopic examination (Pick L.: Zur Histiogenese der Gaucherzellen in der Milz. Virchows Arch. f. path. Anat. **254:** 782, 1925). The authors postulate that similar involvement of the arterioles supplying the epiphyseal center of the femoral head may occur and cause aseptic necrosis. Splenectomy does not appear to hasten the development of bone changes in this disease.

Seven radiographs; 1 photomicrograph; 1 table.
RICHARD P. STORRS, M.D.
Syracuse, N. Y.

Leprous Changes in a Material of Mediaeval Skeletons from the St. George's Court, Naestved. Vilh. Møller-Christensen and Børge Faber. Acta radiol. **37:** 308–317, March-April 1952.

This most interesting study of 200 skeletons from a Danish medieval leper church yard, in use from 1260 to 1542, revealed in about half osseous changes of the same character found in persons suffering from leprosy today. The bodies had not been disturbed, and it was possible to make a detailed examination of entire skeletons. While the changes affecting hands and feet do not differ in the medieval material from that described

in the contemporary lepers, cranial changes were found which, as far as is known, have not been described previously. The "facies leprosa" is characterized by total atrophy of the anterior nasal spine and disappearance of the external compact layers and also of the projecting parts of the facial bones on a level with the lower half of the nasal aperture of the skull. In addition, there is characteristic atrophy of the alveoli of the four upper incisors, so that in advanced cases these teeth are lost or become loose in the gingiva. Since these cranial changes have been found only in association with typical leprous changes in the hands and feet and have not been described in other diseases, it seems justifiable to assume that they are diagnostic of leprosy.

Eight roentgenograms; 3 photographs.

DAVID C. GASTINEAU, M.D.
Indiana University

"Stippled Epiphyses" in the Newborn and in Infants. (Synonyms: Chondrodystrophia Calcificans Congenita, Dysplasia Epiphysialis Punctata). Eyvind Mosekilde. Acta radiol. **37**: 291–306, March–April 1952.

Although of not very frequent occurrence, irregular ossification of the epiphyses and apophyses (fragmentation, segmentation, punctation, mottling, and multiple ossification centers) is occasionally encountered in radiologic practice. The author was able to find 39 cases in the literature. He reports 3 more, one with the autopsy findings. Five clinical signs may be said to constitute a typical picture: (1) micromelia and rhizomelia; (2) additional shortening of 1 to 4 cm. in one or two extremities (usually femora or humeri); (3) semiflexion and limitation of extension of the larger joints; (4) bilateral congenital cataracts; and (5) stippled epiphyses. Other congenital anomalies frequently accompany this disorder. Blood examinations have shown no consistent findings in analysis of the serum calcium, phosphorus, or serum phosphatase.

Roentgenologic signs are of decisive importance in establishing the diagnosis. Most frequently, these occur in the extremities, notably those affected by shortening or deformity. They occupy all or part of the epiphyseal and apophyseal cartilages and appear either before or simultaneously with the development of the ossification centers. These densities (stippling) are of three types: (1) single, scattered, well-defined rather regular densities; (2) numerous, often highly irregular densities occupying the greater part of the epiphysis, and (3) cloudy densities occupying more or less of the cartilage. The densities may either be slowly resorbed or be gradually incorporated into the normal ossification center during its growth.

The prognosis in "stippled epiphyses" is poor. Some children have died of their associated congenital anomalies, but most have died of superimposed infection.

The etiology and pathogenesis are unknown, and therefore causal therapy is impossible. Therapy should be aimed at the myogenic and dermatogenic contractures. The author believes that most cases must be considered a form of chondrodystrophy, possibly associated with disturbances in the calcium metabolism in mother or child.

Eight roentgenograms; 2 photographs.

DAVID C. GASTINEAU, M.D.
Indiana University

Concerning Two Cases of Renal Osteodystrophy. P. Wellens and M. Persyn. J. belge de radiol. **35**: 603–616, 1952. (In French)

In renal osteodystrophy progressive diminution of renal function is accompanied by diverse osseous lesions and a certain degree of dwarfism. Renal lesions found in patients with this syndrome include chronic glomerulonephritis, pyelonephritis, nephrosis, polycystic kidneys, renal hypoplasia, urinary tract obstruction, and various tubular lesions. The latter include conditions of hypochloremia with glycosuria (syndrome of Toni-Fanconi) and hyperchloremia without glycosuria, accompanied by nephrocalcinosis. Extra-renal factors include primary hyperparathyroidism with secondary renal lesions, disturbance of cystine metabolism with sclerotic kidneys, and secondary hyperparathyroidism following hypocalcemia as seen in avitaminosis D, biliary fistula, chronic icterus, and sprue.

Osseous changes are based on four elementary considerations: generalized osteoporosis, reactive osteosclerosis, abatement of ossification, and retardation of osteoid growth.

Half of the patients present a generalized osteoporosis. This osteoporosis is less apparent in some instances because of a reactive osteosclerosis which tends to make less clear the delineation of cortical and spongiosal bone. The fingers show osteoporosis and even a fibrocystic appearance. The cranial vault is thickened, with lack of delineation of internal and external tables. Various degrees of osteoporosis and reactive osteosclerosis are seen in both the skull and spine. The sacroiliac joints may appear effaced. Pseudofractures of the Milkman-Looser type may occur. Decalcification of the lamina dura about the teeth is seen. Subperiosteal erosion is noticed most often in the phalanges, proximal tibia, elbow, and distal extremity of the clavicle.

Retardation of growth is due to tardy formation of the osteoid substrate of the epiphyses. This separates renal rickets from rickets of the usual type. In both there is imperfect calcification of the osteoid when formed.

Ten roentgenograms; 1 drawing.

CHARLES M. NICE, M.D.
University of Minnesota

THE GENITOURINARY SYSTEM

Diagnostic Kidney Puncture in Cysts and Tumors. K. Lindblom. Am. J. Roentgenol. **68**: 209–214, August 1952.

A method of percutaneous puncture of the kidney is described. During intravenous urography or retrograde pyelography the patient is placed in the prone position with the diseased side slightly elevated. During roentgenoscopy, a centimeter scale is placed on the back, opposite the kidney. In the lateral view the depth of the kidney and the focus from the skin is determined by the aid of a scale. After anesthetization of the skin and muscles of the back opposite the expanding focus, a small puncture needle is inserted into the focus. Ordinarily, in the cases of cyst the fluid flows out immediately, while from most tumors blood drips out instead. Since some tumors are associated with cyst formation, since blood may be obtained from normal kidney tissue, since some tumors produce no blood, and since bleeding was occasionally seen from a lesion of the cyst wall, the examination is made more accurate if a 35 per cent solution of Diodrast is injected into the focus. Anteroposterior and lateral roentgenograms are then taken.

The appearance of the contrast medium in either cysts or tumors is considered typical. Aspiration of a cyst may be curative.

The indications for diagnostic kidney puncture were an expanding focus found at urography in cases with hematuria; increased blood sedimentation rate; fever; tumor metastases with no other signs or symptoms. One patient who was operated upon without puncture was found to have a cyst with a giant-cell tumor of a lumbar vertebra (preoperatively presumed to be metastatic from a renal neoplasm). This case strengthened the author's belief that a diagnostic puncture is indicated in every case in which the diagnosis of a tumor is questionable. The kidney need not be punctured in cases with definite signs of tumor, such as projection of the tumor into the pelvis, very irregular deformity of the pelvis, and large solid tumors with decreased kidney function. Spot-like calcifications in the expanding focus were found only in tumors, while a calcified shell occurred in cysts.

The author feels that puncture is technically easier and gives more accurate information than aortography since some hypovascular tumors may be mistaken for cysts on aortography.

Fourteen roentgenograms; 2 photographs.

L. A. PILLA, M.D.
University of Louisville

Supernumerary Ureter with Ectopic Orifice. Report of Two Cases. Ulla Arlien-Søborg. Acta radiol. **37**: 183–188, March–April 1952.

Two cases of supernumerary ureter with ectopic orifice are reported.

One patient, a 9-year-old girl, was admitted to the hospital with a constant vaginal discharge and occasional incontinence. An elongated mass could be palpated in the vaginal wall; on pressure, this mass discharged pus through a small orifice in the distal part of the urethra. A catheter was inserted through this orifice. Direct pyelography demonstrated a tortuous blind ureter. This finding was confirmed at surgery. Microscopic examination showed a tubular cord, made up as a ureter and without any renal tissue at the upper pole. The wall was inflamed.

The second patient was a 41-year-old woman who had always suffered from urinary incontinence. She was admitted to the hospital with a high-grade fever and pain in the left lumbar region. The roentgen diagnosis was perirenal abscess (? pyonephrosis). Operation revealed a perirenal abscess and an orange-sized pyonephrosis in the upper renal pole and a smaller pyonephrosis in the lower pole, but only one ureter. Fluid injected into the postoperative wound appeared in the urethra. Roentgen examination demonstrated a supernumerary ureter ending distally in the urethra. At a second operation this ureter was extirpated; it was believed that it had been severed at the previous operation. Incontinence was completely relieved.

Urinary incontinence in the female should always make one suspicious of a ureter with an ectopic opening. The orifice in the urethra may be difficult to find, as it may be hidden among the folds of the mucosa. If such an anomaly is suspected, the injection of a dye, followed by probing and injection of contrast medium, is indicated.

Three roentgenograms.

DAVID C. GASTINEAU, M.D.
Indiana University

Ureteral Compression Due to Metastasis from Carcinoma of Sigmoid. George R. Krause and Mortimer Lubert. J.A.M.A. **149**: 1555–1557, Aug. 23, 1952.

Metastasis to retroperitoneal lymph nodes from carcinoma of the sigmoid colon or rectum may compress and obstruct the ureters, especially the left one. During the past five years the authors have seen 5 patients who have had at least one ureter compressed by lymph nodes containing tumor that was metastatic from a carcinoma of the distal colon. The primary tumor had been removed from 4 of these patients. In the fifth case, routine investigation of the urinary tract prior to operation disclosed the presence of pressure on the left ureter. These cases are presented briefly.

Studies of the lymphatic spread of carcinomas of the distal colon have been based largely on resected specimens. As a result, there has been much interest in the nodes of the mesocolon itself, with little, if any, stress laid on the relationship of the deeper nodes to the ureter. In contrast the relationship between the lymphatic drainage of the cervix and the ureters is well known in the natural history of cervical carcinoma.

Since the base of the mesocolon lies in intimate relation with the lower part of the left ureter, enlarged lymph nodes in the root of this mesentery may encase or compress the ureter. Compression of the ureter occurs gradually, because the tumor growth in these lymph nodes is slow and there is usually an absence of urological symptoms.

The authors conclude that intravenous urography is an important procedure, preoperatively and postoperatively, in the management of carcinoma of the sigmoid colon and that a more radical surgical approach to carcinoma of the sigmoid colon, either as a primary or palliative procedure, may prove to be necessary.

Three roentgenograms.

ALFRED O. MILLER, M.D.
Louisville, Ky.

A Device for the Protection of the Testicle in Roentgen Examinations of Adjacent Organs and Bones. Wolfgang Magnusson. Acta radiol. **37**: 288–290, March–April 1952.

The effects of roentgen radiation on the testicles is well known, and depopulation of the tubules may be produced by a dose of 60 r. Values as high as 10 r have been measured in obtaining lateral films of the surrounding tissue. It therefore seems desirable to protect the testicles in examinations of non-sterile subjects. The author has had manufactured metal capsules of different sizes in which the scrotum can be easily enclosed and which do not slip off when the patient changes position. The capsule is made of 1.5 mm. nickle-plated brass. It eliminates about 99 per cent of the irradiation during urography and does not interfere with satisfactory roentgenograms.

Two roentgenograms; 2 photographs.

DAVID C. GASTINEAU, M.D.
Indiana University

Diffuse Papillomatosis of the Urinary Tract. Cecil Villaume. Acta radiol. **37**: 401–408, March–April 1952.

A case of diffuse papillomatosis of the urinary tract involving the renal pelves, both ureters, and the bladder is presented. The author states that such widely disseminated papillomatosis is rare. Because of the bilateral diffuse nature of the lesions in the author's

case, surgery was not considered and rotary irradiation of the bladder was carried out (3,600 r in front, 2,400 r behind; "semirotation"). Two and one-half years later a bean-sized recurrence was removed from the bladder. At that time urography showed the condition in the ureters and renal pelves to be stationary.

Excellent diagnostic urograms of the extensive dissemination of papillary tumors throughout the urinary tract are reproduced.

The etiology and pathogenesis, symptomatology, diagnosis, and treatment of papillomatosis are ably discussed, as well as the histology and prognosis. The author emphasizes the fact that papillomata of the urinary epithelium possess marked powers of metastasis by implantation, and that secondary deposits in a part of the ureter and/or the bladder are often found.

Two roentgenograms; 1 photomicrograph.

W. H. SOMERS, M.D.
Indiana University

GYNECOLOGY AND OBSTETRICS

The Diagnosis of Placenta Previa Without the Use of Contrast Media. John S. Fetter. Am. J. Roentgenol. **68**: 255–261, August 1952.

The diagnosis of the presence or absence of placenta praevia can be made with a high degree of accuracy, the author believes, without the use of contrast material. Films of optimum quality are essential, particularly in cases where marginal implantation is suspected. Major diagnostic points are: failure to demonstrate the placental shadow in the fundus of the uterus; displacement of the fetal head from the mid-coronal or mid-sagittal plane of the pelvic inlet; abnormal high position of fetal head in association with adequate pelvic inlet; displacement of the rectum or indentation of its anterior wall; an extra-fetal soft-tissue shadow between the fetal head and the symphysis pubis: obliteration of outline of bladder on anteroposterior views, especially if unilateral; abnormal or unusual attitude of fetus. Unfortunately the reproductions of the films accompanying the article are poor, and the valuable criteria given are not well demonstrated.

Thirteen roentgenograms.

LAWRENCE A. DAVIS, M.D.
University of Louisville

The Accuracy of X-ray Cephalometry in Utero. Derk Crichton. Proc. Roy. Soc. Med. **45**: 535–537, August 1952.

Absolute reliance cannot be placed upon a positive x-ray diagnosis of disproportion. This conclusion is based upon the following considerations:

1. X-ray cephalopelvimetry is frequently performed before term and appropriate allowance must be made for subsequent growth of the fetal head. The average growth rate of the biparietal diameter in 34 cases was found to be 1 mm. per week. A head which will be large at term is already moderately large by the thirty-seventh week. When pregnancy continues beyond term, a similar growth rate must be allowed for.

2. The consequences of flexion and molding of the fetal head should be understood. In a 7½ lb. baby, the area of head engagement may measure 87 cm.² in extension and 72 cm.² in flexion. Average molding of a deflexed head only reduces the presenting area to 82 cm.² whereas average molding of a flexed head reduces the presenting area to 65 cm.²

3. Fetal skulls are only moderately uniform in shape. A disturbingly high variation in head shape exists, particularly among those cases in which cephalometry would be most desirable. First, the direction of the growth of the head tends to be minimal in the path of greatest resistance. Second, the head is gradually "shaped" by abnormal pressure effects. Molding is obvious, rapid in development, and soon disappears. Shaping entails less distortion, is insidious in onset, slow to disappear, and is often overlooked. The phenomenon of shaping is likely to occur after the thirty-seventh week of pregnancy in cases of disproportion and is particularly common in breech presentation. Its presence will lead to serious errors in estimating the size of the fetal head, if complete reliance is placed upon accurate measurement of a single diameter. The biparietal diameter "appears" larger when the skull is rotated away from the true anteroposterior view. The length of the biparietal diameter is not usually affected until the skull has rotated 10°. When the skull rotation amounts to 30°, the "apparent" length already exceeds the true length by 0.6 cm.

Two roentgenograms.

D. DEF. BAUER, M.D.
Coos Bay, Ore.

THE BLOOD VESSELS

Atherosclerosis of the Abdominal Aorta. A Roentgenological Study. Gísli Fr. Petersen. Acta radiol. **37**: 356–363, March–April 1952.

More or less marked evidence of calcification of the abdominal aorta is not an uncommon finding in advanced age, particularly in routine roentgenography of the spine. Aortic calcification occurs in two stages according to its severity or extent: Stage 1, single elongated shadows of calcium or single calcareous patches in a typical site, and Stage 2, calcified shadows in both the anterior and posterior walls. Occasionally irregular calcification affecting a large area or calcification throughout the entire course of the vessel is demonstrable.

The incidence and stage of aortic calcification in age groups and sexes as found in 220 patients are tabulated. Its greatest incidence is in females over fifty years of age.

The significance of roentgen changes in the abdominal aorta and their association with abdominal pain, hypertension, and coronary artery disease are discussed.

Six roentgenograms.

J. R. HALE, M.D.
Indiana University

The Guided Catheterization and Radiography of the Abdominal Vessels. A. M. Rappaport. Canad. M. A. J. **67**: 93–100, August 1952.

A method of guided catheterization of the abdominal vessels, which has been used successfully in experimental animals, is described. The author has devised a plastic catheter with a small metallic cap on the end. Inside the catheter is a flexible metallic removable guide, the end of which can be curved in various directions by turning a nut in its handle. The plastic catheter and leader are inserted usually through the femoral artery or vein (after surgical dissection of the vessel) until the diaphragm is reached. Here the tip of the catheter is curved by twisting the guide handle, and the catheter is withdrawn until the desired vessel is reached. The plastic catheter is then slipped over the leader into the vessel as far as desired and the guide removed,

leaving the catheterized vessel ready for injection of radiopaque substances or other functional studies.

Advantages of the guided method of catheterization of the abdominal vessels are felt to be several. The shadow cast by the metallic leader and the accurate control over the curve and direction of the catheter tip facilitate fluoroscopic guidance of the catheter tip into the desired vessel. Good detail of the vascular pattern of the organs studied is obtained, using a very small amount of radiopaque substance (4 to 10 c.c. of 35 per cent Diodrast solution). Retrograde venography of the hepatic veins requires a concentration of 70 per cent Diodrast. The author believes this method may also allow for direct therapeutic action by drugs, antibiotics, radioisotopes, etc., on diseased organs.

Eight roentgenograms; 2 drawings.

WARREN A. NAFIS, M.D.
Jefferson Medical College

THE DIAPHRAGM

Anomalies of the Right Dome of the Diaphragm. Report of Two Unusual Cases. C. E. Gudbjerg. Acta radiol. **37:** 253–257, March–April 1952.

The author lists the cases of anomaly of the right diaphragm appearing in the more recent Scandinavian literature and reports 2 cases of his own—one a true congenital right-sided hernia through the foramen of Morgagni and the other a congenital right-sided relaxation of the diaphragm with eventration of the right lobe of the liver. The symptomatology and frequency of diaphragmatic anomalies are discussed.

The following classification of diaphragmatic anomalies is given:

1. Diaphragmatic hernia
   - *a.* Congenital
     - True (with hernial sac)
     - False (without hernial sac)
   - *b.* Traumatic (stab wounds, gunshot wounds, traffic accidents, etc.)
2. Relaxation of the diaphragm
   - *a.* Congenital (defective development of the musculature)
   - *b.* Paralytic (resection of the phrenic nerve, tumors, etc.)
3. Absence of the diaphragm.

Four roentgenograms.

J. R. HALE, M.D.
Indiana University

Subcostosternal Diaphragmatic Hernia. E. K. Johnson and Joseph L. Mangiardi. Am. J. Surg. **84:** 245–248, August 1952.

A chest roentgenogram of a nine-month-old baby showed slight displacement of the heart to the left, apparently by a mass which occupied the lower half of the right chest. Radiolucent areas within the mass suggested the presence of gas-containing viscera, and a diagnosis of right subcostosternal diaphragmatic hernia was made. During surgical repair, it was found that most of the small intestine, a portion of the transverse colon, the tip of the right lobe of the liver, and part of the pancreas were in the right chest. The viscera had herniated into the thorax through an opening 3 × 5 cm., *i.e.*, through the foramen of Morgagni. A hernial sac lined by peritoneum was present in the base of the right chest.

Postoperative roentgenograms showed the disappearance of the gas-filled viscera and an essentially normal appearance of the lungs and all portions of the diaphragm at normal levels.

This case is the more interesting because the patient also had congenital heart disease which was diagnosed as tetralogy of Fallot. The coexistence of the two conditions is rare.

Three roentgenograms.

D. DEF. BAUER, M.D.
Coos Bay, Ore.

TECHNIC

New Technics in Nerve Blocks as Suggested by Radiographic Visualization. James C. Appleton. South. M. J. **45:** 681–684, August 1952.

The control of the chronic painful state is discussed with respect to new technics in nerve blocks made simpler by x-ray demonstration of needle placement and the x-ray visualization of the anatomical spread of Diodrast to insure the accuracy of the injection. Among mentioned procedures that were felt to be aided by roentgenography were stellate ganglion block (especially de Sousa Pereira's "gravitation" technic), lumbar sympathetic blocks, and splanchnic blocks. Technics are briefly mentioned. A 6 per cent aqueous solution of phenol is suggested as a good, prolonged, harmless nerve blocking agent.

Two roentgenograms; 1 photograph.

WARREN A. NAFIS, M.D.
Jefferson Medical College

APPARATUS

Cassette Seriograph, 14 by 17 inch, for Aortography, Nephrography and Adult Chest Angiocardiography. A Preliminary Report. Armand E. Brodeur. J. Missouri State M. A. **49:** 670–672, August 1952.

Believing the smaller films inadequate for serial aortography or adult angiography and in certain urological problems, the author has developed a seriograph using 14 × 17-inch film in the usual cassettes. The seriograph is attached by clamps across the radiographic table and is operated manually. A handle pushes the first cassette through a tunnel into position under a Lysholm grid. On the return stroke of the handle, the second cassette falls into delivery position, and a set of microswitches automatically makes an x-ray exposure. The next forward stroke of the handle pushes the second cassette into position for exposure and the first cassette under a lead protected area in the tunnel. On the return stroke of the handle, the first cassette drops into a collecting box and the second exposure is made.

With this equipment, approximately 2 exposures per second are accomplished.

The collecting box is adjustable for varying heights of radiographic tables. It is mounted on wheels to facilitate transportation of the cassettes to the darkroom.

Two photographs.

MARSHALL B. TUCKER, M.D.
Oakland, Calif.

RADIOTHERAPY

Childhood Malignancies. IV. Roentgen-Ray Diagnosis and Treatment. J. E. Miller. Texas State J. Med. **48**: 567–571, August 1952.

Certain malignant neoplasms are relatively common in childhood. Four groups of tumors, namely, malignant lymphomas, brain tumors, abdominal tumors, and bone tumors, are discussed.

Under lymphomas the author mentions the splenic enlargement and bone destruction seen in the leukemias and the bone lesions and mediastinal or hilar masses of lymphosarcoma.

The most common roentgenographic finding in brain tumors in children is separation of the sutures, indicating increased intracranial pressure. Erosion or demineralization of the dorsum sellae and disproportionate increase in the convolutional markings are never seen in children. Calcification above the sella turcica is frequently seen in craniopharyngioma. Calcium in the posterior fossa practically always indicates a cerebellar astrocytoma. Pneumoencephalography usually shows considerable dilatation of the ventricles, displacement, or filling defects.

An abdominal tumor in a child will almost always be either a Wilms' tumor or a neuroblastoma. Although urography is frequently helpful in differentiating between the two, it is not absolute. Roentgen therapy is very important in the management of both of these conditions.

Osteogenic sarcomas and primary chondrosarcomas are the two important malignant osteogenic tumors in children. Ewing's tumor is the most important example of the non-osteogenic type. In general osteogenic tumors and their metastases are radioresistant. Despite the excellent response of Ewing's tumor to irradiation, only an exceptional patient survives five years.

Thirteen roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

On Acne Vulgaris and Its Treatment with Bucky Rays. O. Kaalund-Jørgensen. Acta radiol. **37**: 409–416, March–April 1952.

After reviewing the symptoms of acne vulgaris and the various therapy technics described in the literature, the author reports his results with a method of treatment, the principles of which were laid down by Lomholt. The procedure consists of local treatment with sulfur resorcinol paste, puncture of pustules, and expression of comedones, and Bucky irradiation. For the latter, a Siemens' Bucky apparatus was used. Physical factors were 12 kv., 10 ma., skin-target distance 6 cm., 200 to 300 r at intervals of two weeks. Individual patients received from 3 to 7 exposures, 4 treatments being sufficient in most cases. The author concludes that the treatment involves no risk, is speedy, and cures about seventy per cent of cases of acne vulgaris superficialis. In acne vulgaris profunda, the treatment was generally supplemented by bismuth injections; the results were not so satisfactory.

Two tables.

DAVID C. GASTINEAU, M.D.
Indiana University

Roentgen Treatment of Bronchial Asthma. B. Refslund Poulsen. Acta radiol. **37**: 364–368, March–April 1952.

The author treated with roentgen rays 53 cases of severe chronic bronchial asthma; all the common therapeutic aids had been tried previously. Information concerning results was obtained in 48. In 40 patients irradiation brought about a reduction or complete cessation of asthmatic attacks. In most cases relief came about a week after termination of treatment and lasted about two months, although in some instances the duration of improvement was much longer. No untoward reactions were noted.

The roentgen rays were delivered at 160 kv., with 0.5 mm. Cu and 1.0 mm. Al filtration, at a distance of 30 cm. All patients received treatment over two anterior and two posterior fields (16 × 10 cm.) directed to the right and left hilar regions respectively. Thus, the entire hilar area and the greater part of the lungs were irradiated. The dosage was 100 r × 4 to each of the fields; two treatments were given at a time with an overall time of eighteen days. Eight of 10 patients treated a second time obtained essentially the same improvement as with the first course.

The author discusses his views and those of other investigators on the mode of action of roentgen rays in asthma.

It is the author's opinion that roentgen therapy should not be used for asthma in children. It is recommended as a palliative measure in middle-aged and elderly patients with asthma of long standing. It should not be instituted in any patient, however, until all other therapeutic procedures have been given a trial.

W. H. SOMERS, M.D.
Indiana University

Primary Malignant Tumors of the Nasopharynx. Robert M. Geist, Jr., and U. V. Portmann. Am. J. Roentgenol. **68**: 262–270, August 1952.

Malignant tumors of the nasopharynx comprise from 1 to 2 per cent of all cancers. In the authors' series of 72 cases of primary malignant tumors of the nasopharynx, there were 46 men and 26 women. The average age was 46.7 years.

Grossly, tumors of the nasopharynx may be divided into three types: ulcerated, lobular, and exophytic. The ulcerated lesions are usually differentiated squamous-cell carcinomas, which eventually involve the cranial nerves and the bones of the base of the skull. The majority of the lobulated tumors are transitional-cell carcinomas or lymphoepitheliomas; they often spread submucosally. Exophytic tumors generally arise from the posterior nasopharyngeal wall and are usually sarcomas.

In the present series of 72 cases, there were 21 transitional-cell carcinomas, 19 squamous-cell carcinomas, 9 lymphoepitheliomas, and 4 undifferentiated small-cell carcinomas. There were 9 sarcomas (6 lymphosarcomas, 1 reticulum-cell sarcoma, 1 fibrosarcoma, 1 lipomyxosarcoma). Eight tumors could not be classified.

Auricular symptoms were the initial complaints of 18 per cent of the patients in the present series (closure of eustachian tube, absorption of air and accumulation of secretion in middle ear, otalgia, infection). The initial symptoms were in the upper respiratory tract in 28.7 per cent of the patients (intermittent unilateral nasal obstruction, rhinorrhea, and repeated unexplained hemorrhages) and nodal in 32 per cent (painless swelling in neck, palpable at first examination in 65.6 per cent).

In 23.6 per cent the initial symptoms were neurologic (involvement of cranial nerves due to proximity to base of skull and particularly to the foramen lacerum and foramen ovale).

If untreated, malignant tumors of the nasopharynx lead to generalized carcinomatosis. The average length of life after onset of symptoms in the untreated patient in this series was 17.6 months.

Radiotherapy is the only acceptable treatment for malignant tumors of the nasopharynx. The technic employed at the Cleveland Clinic is described. The tumor dose should be at least 4,000 r. Occasionally a second course of x-ray therapy is administered after several months. Radon seeds are implanted following external roentgen irradiation in well differentiated squamous-cell carcinomas and adenocarcinomas when a high local dose of radiation is essential. When cervical lymph-node metastases are present, in most cases even though not palpably enlarged, an attempt is made to irradiate lateral fields of the neck. Large fields are used in anaplastic tumors; the dose of radiation is carried to skin tolerance. In advanced carcinomatosis, roentgen therapy is of value for relief of pain; a skin dose of 1,500 to 2,500 r is given to medium sized fields. Pain due to bone metastasis is well controlled, except that due to invasion of the base of the skull, for which various neurosurgical procedures may be used.

The prognosis in malignant tumors of the nasopharynx is poor. Widely different percentages of cures have been reported. It is difficult to compare accurately the statistics because of the variation in stages of the disease in different series. For this reason the authors submit the following classification: Stage I: Tumor limited to nasopharynx; no palpable lymph nodes and no neurologic signs; Stage II: Palpable cervical nodes; no other evidence of metastases or extension and no neurologic signs; Stage III: Local invasion of orbit, sinuses, or base of skull; neurologic signs; general carcinomatosis.

Of 13 Stage I cases treated by the authors, 8 lived for more than three years and 3 for longer than five years. Of 17 Stage II cases treated, 3 lived longer than three years and 1 for more than five years. Of 8 Stage III cases treated, 3 lived more than one year but none as long as two years. Histopathologically, there was no specific group in which results of treatment were outstanding.

Four roentgenograms; 1 chart; 3 tables.

L. A. PILLA, M.D.
University of Louisville

Discussion on the Place of Radiotherapy in the Treatment of the Arthritic Joint. Leslie Hill and B. W. Windeyer. Proc. Roy. Soc. Med. **45:** 543–548, August 1952.

In Hill's opinion radiotherapy is of value in various types of arthritis. He believes the effect is due to hyperemia and a temporary suppression of nerve endings. During the past five years over 2,400 cases of various kinds of joint disease have been treated by roentgen therapy at the Radiotherapy Center, Bath, England. Dosage ranged from 200 r for interphalangeal joints up to 1,200 r (tissue dosage) for hip joints and 1,500 r to the spine (220 kv., with half-value layer of 1.5 Cu). Cases treated slowly (twice a week for three or four weeks) responded better than those treated daily.

Radiotherapy in rheumatoid arthritis was found to be of doubtful value. It is contraindicated in the acute joint and should not be used in debilitated individuals.

The response of the osteoarthritic joint to deep x-ray therapy is more favorable than that of the rheumatoid joint. Cases in which osteophytic lipping is a feature respond better than those with predominantly degenerative changes. In osteoarthritis of the cervical and dorsal spine, with root symptoms, the referred pain is often relieved to a greater extent than the local symptoms; in the lower spine, pain and referred sciatic symptoms are more refractory to treatment. Pain on rest in the hips and knees is often relieved by x-ray therapy, and the treatment is well worth giving in these cases. Little benefit accrues when there is gross destruction of the joint.

In ankylosing spondylitis x-ray treatment is undoubtedly of great value in the relief of pain and the restoration of movement and also occasionally in the arrest of the disease process itself.

The care of the patient on general medical lines must not be neglected. Physiotherapy, orthopedic measures, and general medical care are invaluable. The chief danger of x-ray therapy is the effect on the hemopoietic system.

Windeyer discusses his experience at the Middlesex Hospital, London, with the x-ray treatment of subacromial bursitis, rheumatoid arthritis, osteoarthritis, and ankylosing spondylitis. In the patients with subacromial bursitis there was usually some improvement in the aching pain by the end of the course of x-ray therapy; within three to four weeks of completion of treatment the pain had disappeared and a full range of painless movement was soon regained. No improvement was obtained from x-ray therapy in patients with rheumatoid arthritis. About one-half of the patients treated for osteoarthritis obtained palliation. X-ray therapy was of the greatest value in the treatment of ankylosing spondylitis and revolutionized the management of this condition. After a course of irradiation, in almost all cases with active disease, there was relief of pain and muscle spasm.

D. DEF. BAUER, M.D.
Coos Bay, Ore.

Treatment of Eosinophilic Granuloma with Roentgen Rays. R. Töppner. Strahlentherapie **88:** 362–376, 1952. (In German)

Eosinophilic granuloma was described in 1940 by Otani and Ehrlich (Am. J. Path. **16:** 479, 1940) and in 1944 by Jaffe and Lichtenstein (Arch. Path. **37:** 99, 1944. Abst. in Radiology **43:** 414, 1944). In reviewing the literature, it is pointed out that the etiology of this disease is still unknown. It has been classified as tumor, chronic infection, and lipoid dystrophy.

According to Schinz (Lehrbuch der Röntgendiagnostik, 1950), four phases of eosinophilic granuloma can be distinguished histologically: (1) the proliferative phase, (2) the granulomatous phase, (3) the xanthomatous phase, (4) the change from granulomatous tissue into scar and later bone tissue.

Clinically the disease has a sudden onset with pain in the affected area. A lesion may be dormant for a long time. Osteolytic foci without periosteal involvement are recognized radiologically. The disease is more frequent in young males. Because of the difficulty of differential diagnosis, a biopsy is recommended in all cases.

The author describes 4 cases of his own in males ranging in age from eighteen to forty-seven years. Eosinophilic granuloma was found in the upper and

lower jaws, pelvis, ribs, metaphyses of long bones, and vertebral bodies. All of these cases were treated with roentgen rays, giving a tumor dose varying from 400 to 2,000 r. A few lesions were treated postoperatively. The author is of the opinion that roentgen therapy of eosinophilic granuloma is the treatment of choice. A tumor dose of 2,000 r is the maximum. Pain disappears soon after irradiation and, as a rule, no recurrences are observed.

Nine roentgenograms; 4 diagrams.

EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

A Twenty-Five Year Evaluation of the Treatment of Carcinoma of the Cervix with Irradiation. Lewis C. Scheffey, William J. Thudium, David M. Farell, George A. Hahn, and Warren R. Lang. Am. J. Obst. & Gynec. **64:** 233–247, August 1952.

An evaluation and critical analysis of 485 patients seen and/or treated by irradiation for carcinoma of the cervix on the ward service of the Division of Gynecology, at Jefferson Medical College, from Sept. 1, 1921, to Sept. 1, 1946, are presented, with a follow-up record of 98.5 per cent. The present report is a continuation, so to speak, of four earlier ones published successively in 1931, 1936, 1942, and 1949. (See Absts. in Radiology **18:** 671, 1932; **40:** 110, 1953; **54:** 794, 1950.)

From Sept. 1, 1921, until Sept. 1, 1946, a total of 548 patients with carcinoma of the cervix were seen. Only 8 of these were untraced, and 4 of these 8 were followed from eight to eighteen years. Owing to the difficulty in evaluating relative results and changing technics, those patients seen elsewhere (Group V, Schmitz) are excluded in computing the relative survival figures. The methods of diagnosis and the "delay period" are discussed.

Radiation therapy has undergone certain changes in principle over the twenty-five years covered by the report. (1) From 1921 to 1936, massive local radium application was used, with x-ray therapy before or after the radium. (2) From 1935 to 1942, preliminary roentgen irradiation was given, followed in three to four weeks by radium applications. (3) In 1942 vaginal cone therapy was added to the preliminary x-ray technic, followed by local radium. The five-year survival rate has increased with each method as follows: (1) 1921–36, 27.9 per cent, (2) 1936–42, 34.6 per cent, (3) 1942–46, 47.6 per cent.

Postirradiation changes are discussed. It is evident that increased survival rates have been accompanied by a higher incidence of bowel and bladder disturbances. Further improvement in irradiation methods is vital if serious damage to normal tissue is to be avoided.

Thirteen tables.

JOHN M. KOHL, M.D.
Jefferson Medical College

Carcinoma of the Cervix—Results of Radiation Therapy. Thomas Harrold and J. Benham Stewart. J.M.A. Georgia **41:** 336–343, August 1952.

The authors report the five- and ten-year results of treatment of 470 cases of carcinoma of the cervix with radium and x-rays. Ninety per cent of the patients were satisfactorily followed, either to death or for a minimum period of five years. The absolute five-year survival rate was 30 per cent. The absolute five-year survival rate in Groups I and II (Schmitz classification) was 48.6 per cent. In the patients with complete treatment and complete follow-up, the five-year survival rate was 40 per cent and the ten-year survival rate 31.8 per cent.

The basic treatment consisted of approximately 2,500 mg. hr. of radium in the uterine canal, followed in three to six weeks by 2,500 mg. hr. of radium to the vaginal fornices. The second radium treatment is routinely given in a double colpostat, with the radium located in two rubber cylinders. When this method of application has not been feasible, a radium bomb made of lead has been used or, in a few instances, a radium plaque made of cloth with radium tubes sutured to it has been packed against the surface of the cervix. A month later roentgen therapy is begun. As a rule 1,800 to 2,000 r are delivered through each of two anterior and two posterior ports, 15 × 15 cm. in diameter. Physical factors are 200 kv., 0.5 mm. Cu and 1.0 mm. Al filtration, 50 to 70 cm. distance.

The authors discuss the complications of radiotherapy (infection, sloughing, fistulas, ureteral obstruction), without giving any detailed statistics for their series.

Nine tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

A Modern Radium Distribution System for the Johannesburg General Hospital. M. P. Shapiro and Lionel Cohen. South African M. J. **26:** 697–700, Aug. 30, 1952.

The problem faced by the authors was the treatment of a large volume of new patients with malignant neoplasms annually, with a relatively small amount of the radium element. Furthermore, the sizes and strengths of the radium element available were not always desirable for the particular patient to be treated. An additional disadvantage was the gross inaccuracy in the placement of the needles freehand, which was inseparable from the classical radium needle system being used.

Without purchasing additional radium, all of the difficulties were solved by adopting a modified radium mounting procedure. Basically, the system entails the use of radium cells individually placed in sheath needles with detachable points and eyelets. The system also employs suitable metallic stabilizers to maintain certin fixed positions between the needles.

In interstitial radium implants, one or more planes, each consisting of a number of parallel cell-loaded needles are prepared before surgery and the relative position of the needles is fixed by attachment to a stabilizer. The sheaths may be loaded with maximum activity at the periphery of the plane, removing the necessity of "crossing the ends." The tissue dosages are calculated according to the volume or area of the implant. It has been the authors' experience that a remarkably uniform tissue dosage is possible with the use of the stabilized or fixed needles.

The individual radium element cells are mounted in various sized capsules and then used in the standard manner in intracavitary irradiation. For example, in the treatment of carcinoma of the cervix, the capsules have been used in the Manchester type ovoids and in an Ernst type applicator.

In the treatment of surface lesions, the radium cells are arranged in circles or rectangles, strictly according to the Paterson-Parker system.

Six roentgenograms; 2 diagrams; 1 photograph.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

RADIOISOTOPES

Clinical Use of Radioactive Isotopes. C. H. Jaimet. Canad. M. A. J. **67:** 108–112, August 1952.

This is a brief general review of the clinical applications of radiophosphorus, radioactive gold, and radioiodine. It includes a description of three types of high-efficiency scintillation counters designed and constructed at McMaster University, Hamilton, Ontario, for (1) the determination of radioiodine uptake and tumor localization; (2) for regional scanning of radioiodine activity in the thyroid; (3) for the measurement of radioiodine in blood or the measurement of "iodine conversion ratios" (ratio of protein-bound iodine activity to total blood activity twenty-four hours after oral administration of a tracer dose).

Artificial Radioactive Sources for Interstitial Therapy. W. K. Sinclair. Brit. J. Radiol. **25:** 417–419, August 1952.

Artificial radioactive sources suitable for interstitial therapy are discussed.

Tantalum wire sheathed in platinum has been used in place of radium needles, its flexibility being an advantage in some sites of the body. It has some advantages over cobalt wire. It is less brittle, less expensive, and less difficult to sheath. Another important consideration is that metallic cobalt is absorbed from the tissues and deposits in other parts of the body. Tantalum wire, 0.2 mm. in diameter, with a 0.1 mm. platinum sheath, irradiated for a month at a pile factor of about 4.5, will give approximately 0.9 mc./cm. (equivalent to 0.66 mg./cm. of radium), which is a convenient value for interstitial technics. It has been used in the treatment of retinoblastoma and carcinoma of the bladder. For irradiation of the tongue and palate, wire of twice the diameter, with the same sheath thickness, is better and has the added advantage of shortening the radiation time by a factor of 4 to give the same activity per unit length.

Gold grains encased in platinum have been used as a substitute for radon seeds. They are introduced by a special "gun" (see following abstract). The gold grains produce approximately the same reaction as radon seeds, while the handling procedure is simpler and less hazardous. Their cost is about the same as that of radon seeds, but the unused grains may be reirradiated.

One illustration. SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

A Gun for Interstitial Implantation of Radioactive Gold Grains. H. J. Hodt, W. K. Sinclair, and D. W. Smithers. Brit. J. Radiol. **25:** 419–421, August 1952.

A schematic diagram of an introducer, or "gun," for implanting radioactive gold seeds is shown. The duralumin magazine of the gun is loaded with 15 inactive gold grains and is then irradiated in the atomic pile for one week under conditions to give the desired activity on the day the grains are to be used. The operation of the gun is briefly described. The instrument has been employed so far for the implantation of radioactive gold grains into skin tumors, secondary lymph-node metastases and bladder tumors, and for inoperable carcinoma of the stomach.

One roentgenogram; 3 photographs; 1 drawing.
SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Radioactive Tantalum Wire Implantation as a Method of Treatment for Early Carcinoma of the Bladder. D. M. Wallace, J. E. Stapleton, and R. C. Turner. Brit. J. Radiol. **25:** 421–424, August 1952.

A method of implanting radioactive tantalum wire (Ta^{182}) for the treatment of carcinoma of the bladder is described. When an implant of the bladder is contemplated, tantalum wire of the required activity is cut in suitable lengths, each of which is then bent into the shape of a hairpin. The bladder is opened in the usual manner through a suprapubic incision and the tumor is removed by diathermy down to the bladder muscle. By means of a special "introducer" the wire is drawn into position. When the wound is closed, anteroposterior and lateral roentgenograms are taken and from these films the dose rate given by the implant is assessed by a physicist. When the time for the prescribed dose has elapsed, the wires are withdrawn through the urethra.

The principal advantages of this technic are: (1) It is possible to obtain a geometrically satisfactory implant curved to fit the bladder wall. (2) The dose given may be controlled by varying the time the implant is left in position. (3) No foreign bodies are left permanently in the bladder. (4) A stock of radioactive tantalum wire can be kept in store for use at any time.

The immediate response in the first few patients treated by this technic has been good.

One roentgenogram; 5 photographs.
SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Effects of Sodium Iodide, 6-Propyl-Thiouracil, and 1-Methyl-2-Mercaptoimidazole During Radioiodine Therapy of Hyperthyroidism. Howard B. Hamilton and Sidney C. Werner. J. Clin. Endocrinol. & Metab. **12:** 1083–1094, August 1952.

Radioactive iodine (I^{131}) is established as an effective agent in the treatment of hyperthyroidism. There is, however, a latent period of four to eight weeks between administration of the isotope and clinical effect. It would be valuable to be able to obtain earlier control over toxicity during this interval by using antithyroid drugs. Accordingly the authors have tested and recorded the results of giving sodium iodide, 6-propylthiouracil, and 1-methyl-2-mercaptoimidazole for a short period following administration of I^{131}.

A group of 80 adult patients with diffuse toxic goiter were treated by one of four methods: Group I received only I^{131}, in full therapeutic doses; Group II, the isotope and sodium iodide; Group III, the isotope and 6-propylthiouracil; Group IV, the isotope and 1-methyl-2-mercaptoimidazole. The size of the groups was essentially equal. Isotope dosage was determined by the degree of toxicity and gland size. Uptake was measured directly over the gland at twenty-four hours, and the effective half-life within the gland was determined by weekly measurements over the gland for four weeks following therapy.

Antithyroid therapy, when used, was begun one week after administration of I^{131} and continued for two subsequent weeks only, after which no further treatment was given. The serum precipitable iodine and basal metabolic rate were determined in most cases. These values and uptake percentages are given in tabular form. Serum precipitable iodine values are also pre-

sented graphically for all four groups. Final clinical assessment on follow-up data is presented in tables.

Inorganic iodides and antithyroid drugs tend to inhibit uptake of I^{131} by the thyroid. For this reason these agents were not employed in this study until one week after isotope administration so that an effective half-life could be established; they were discontinued after two weeks so that their influence would be dissipated by the time a therapeutic effect of the isotope might be expected.

It was found that an early and significant reduction in the serum precipitable iodine level was induced by 1-methyl-2-mercaptoimidazole but not by sodium iodide or propylthiouracil. Clinical improvement was noted with sodium iodide and with 1-methyl-2-mercaptoimidazole several weeks before the effect from radiation with radioiodine could have been expected. This was not true with 6-propylthiouracil.

The percentage of patients achieving remission from a single dose of isotope may have been reduced, and the total dosage of I^{131} required to induce remission increased, as a consequence of the supplementary medication. Only borderline statistical significance can be attributed to this finding.

The effective half-life of the isotope within the gland has been unaltered by iodides or antithyroid drugs used in this study.

Eight tables; five graphs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

The Lewis A. Conner Memorial Lecture. The Heart and the Thyroid: with Particular Reference to I^{131} Treatment of Heart Disease. Herrman L. Blumgart and A. Stone Freedberg. Circulation **6**: 222–237, August 1952.

The physiologic, pathologic, and clinical interrelationships between the thyroid and the cardiovascular system are discussed.

The therapeutic effects of hypothyroidism induced by I^{131} in 39 euthyroid patients with intractable advanced angina pectoris or congestive failure are described. Only patients were treated who were seriously incapacitated despite all conventional forms of therapy for many months or years.

No radiation sickness and no toxic effects on the blood, kidneys, or parathyroids were observed. Mild or moderate transitory thyroiditis occurred in approximately one-half of the patients.

Twenty-six patients with angina pectoris have been observed for twelve to forty months after treatment with I^{131}. The etiology of the angina pectoris was coronary sclerosis in all. The average duration of angina pectoris before treatment was 5.6 years. One-third of the patients obtained excellent results; in another third the improvement, while less, was distinctly worth while. In the remaining one-third the results were not worth while.

Thirteen of the 39 patients were incapacitated primarily because of congestive heart failure. In 6 patients the results of treatment with I^{131} were worth while and in 7 they were not. The duration of the worthwhile improvement averaged twenty months, with a range of nine to thirty-five months.

The results of two confirmatory series of cases similarly treated elsewhere are reviewed.

Six diagrams; 4 tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Arthritic and Rheumatoid Symptoms in Hyperthyroid Individuals Treated with Radioiodine (I^{131}). R. Prévôt and W. Horst. Strahlentherapie **88**: 253–260, 1952. (In German)

The authors report the results of treatment with I^{131} in 100 patients suffering from various degrees of thyrotoxicosis. Ninety-two patients were definitely benefited by the treatment, while 8 were only slightly improved.

Because of the difference in the clinical response to the amount of irradiation, it is recommended that the dosage be determined in roentgen equivalents per gram of thyroid tissue. Fractionated "radioresection" of the thyroid is suggested to obtain a satisfactory clinical result with a minimum dose.

Concerning the possible development of cancer in later years, the authors state that only in experimental animals given extremely high and unphysiological doses of I^{131} has thyroid cancer been observed.

In 13 of the 100 patients in the present series, rheumatoid symptoms appeared or a previously existing arthritis showed cinical signs of aggravation. In 3 of these cases the symptoms developed into a chronic or subchronic stage; these cases are discussed in detail. This arthritis is regarded, in part, as the expression of a reciprocal action between the thyroid and adrenal cortex, due to a disturbance of the normal compensation during the destruction of functioning thyroid tissue. This leads to the disguised "adaptation syndrome" described by Selye (1951).

It is therefore suggested that cases of toxic goiter associated with rheumatoid arthritis be treated carefully, using a fractionated method. This is an added reason why the "radioresection" of the thyroid is preferred to radical surgical intervention which produces a sudden change and has a primary mortality varying from 0.75 to 2.4 per cent.

EUGENE F. LUTTERBECK, M.D.
Chicago, Ill.

RADIATION EFFECTS

Leukemia and Other Malignancies in Physicians. Sigismund Peller and Paul Pick. Am. J. M. Sc. **224**: 154–159, August 1952.

Using the necrology section of the Journal of the American Medical Association during the years between Jan. 1, 1947, and Dec. 31, 1951, as a source, the authors have made a statistical analysis of the cause of death of all physicians. In the five-year period, a total of 14,516 physicians were reported dead, but the cause of death was disclosed in only 11,481 cases (79.2 per cent). Leukemia appeared as a cause of death 133 times (1.2 per cent), and all other neoplasms 1,426 times (12.4 per cent). In all age groups the ratio of leukemia to all malignant growths is two to three times higher than in the white male population. The authors found that radiologists, dermatologists, and other physicians who use roentgen apparatus have a markedly increased mortality from leukemia, even in the youngest age group.

In the age group, twenty-five to thirty-four years, physicians have an increased mortality from cancers other than leukemia, whereas the risk of dying from a non-leukemic neoplasm in the group, forty to seventy-four years, is diminished.

The authors found no increased incidence of soft-tissue malignant tumors in the physicians exposed to x-rays (this was investigated since bone marrow is not the only tissue irradiated during fluoroscopy).

[Without denying the truth of these findings it must be kept in mind that exact figures in such a study mean nothing. To begin with, in 20 per cent of the physicians no cause of death was given and these deaths had to be discarded in the calculations. How many of these were due to malignant tumors? And in the control group (the official U. S. Government listing of causes of death for 1948) how many cases were autopsied? How many deaths were reported as due to bronchopneumonia because of the supposed stigma of that awful word, "cancer"? Could not the increase in other neoplasms in the younger age group be due to more accurate reporting in the physician's obituaries? The risk of leukemia, however, is undeniable and can scarcely be overemphasized to those who work daily with roentgen rays.—Z.F.E.]

Three tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Erythema Multiforme Following Deep X-Ray Therapy. Jeff Davis and George T. Pack. Arch. Dermat. & Syph. **66:** 41–48, July 1952.

The clinical, pathological, and laboratory features of erythema multiforme due to deep x-ray therapy are presented and analyzed, on the basis of 32 cases collected from the literature and 5 cases in which the patients were examined and treated by the authors. The following evidence has been given to establish this type of reaction to local deep x-ray irradiation as a distinct entity: (1) A prodromal period occurred in each instance following deep x-ray therapy. (2) Radiation sickness or toxic constitutional symptoms were present in severe cases. (3) Eosinophilia, leukopenia, and mild kidney damage were demonstrated as evidence of massive x-ray effect. (4) The response of the syndrome to antihistamines and the ability of these drugs to inhibit the reaction were demonstrated. (5) Radiosensitivity of the tumors was apparent in many of those patients in whom the reaction occurred. (6) The cutaneous reaction was reproduced experimentally in 2 of the authors' own patients and in 2 patients whose cases are reported in the literature.

One photograph; 2 tables.

Problems in Radiation Monitoring with Film-badges. C. B. Madsen. Acta radiol. **37:** 284–287, March–April 1952.

Certain limitations of the film-badge method for determining the amount of irradiation received by personnel in radiologic work are discussed, and errors due to the quality of the radiation are emphasized. A special type of cassette with metal foil filters for film-badges is described and illustrated. The author believes that with the use of this cassette a greater accuracy and an estimation of the nature of the radiation is obtained.

One photograph; 1 table. C. R. MCINTIRE, M.D.
Indiana University

Substitute Bladder after Pelvic Evisceration for Treatment of Radiation Necrosis. Don S. Wenger. Ann. Surg. **136:** 330–333, August 1952.

The problem of treatment of radiation necrosis in the pelvis is one that deserves discussion because its solution is inadequate and difficult at the very best. The scarring, the loss of blood supply, the destruction of tissues resulting in multiple fistulas, and the likelihood of malignant change make local procedures useless. Treatment of lesions resulting from radiation necrosis must be accomplished by using tissues remote from the damaged area. The author describes a case of severe radiation necrosis of the tissues of the pelvis in which the ascending colon and cecum were utilized as a bladder by swinging them transversely and using the terminal few inches of ileum as a urethra exiting from the right lower quadrant. A postmortem examination eight months later showed the newly constructed bladder in excellent condition grossly.

One roentgenogram; 1 photograph; 1 diagram.
DANIEL WILNER, M.D.
Atlantic City, N. J.

The Safety Factor in Ultrasoft Roentgen Irradiation. Erik Ebbehøj. Acta radiol. **37:** 241–245, March–April 1952.

The author points out that we do not know exactly at what depth in the skin the radiation damage resulting in radionecrosis occurs. This probably varies with the thickness of the skin and its blood supply. The untoward effects are probably a combination of injuries occurring at a depth of 3 to 8 mm. In this study the author assumes that the damage takes place at a depth of 3 mm. in order not to minimize the harmlessness of the ultrasoft roentgen rays. It was also assumed that most skin lesions for which irradiation is used are situated 2 mm. or less beneath the surface.

It was found that when 100 r was delivered at various depths beneath the skin surface up to 2 mm., the number of roentgens delivered at the critical depth of 3 mm. was very significantly less for ultrasoft radiation of half-value layer of 0.12 mm. skin than for 130 kv. radiation. This difference was less when based on 100 r delivered at a depth of 2 mm. than when based on 100 r delivered at a depth of 0.3 mm.

The author concludes, therefore, that the risk of radionecrosis is almost the same when using radiation produced at 130 kv., 60 kv., or from contact roentgen tubes. The risk is reduced by using ultrasoft roentgen rays. The softer the quality of the ultrasoft rays, the smaller the risk of radionecrosis, the wider the range of therapeutic effect, and the greater the safety factor.

Four tables. WILLIAM J. LITTLE, M.D.
Indiana University

Modification of Acute Irradiation Injury in Mice and Guinea Pigs by Injection of Bone Marrow: A Histopathologic Study. Charles C. Congdon, Delta Uphoff, and Egon Lorenz. J. Nat. Cancer Inst. **13:** 73–107, August 1952.

Injury to the blood-forming organs is the most important single cause of death in acute total-body irradiation when one considers morphologically demonstrable alterations. Other biological systems may be injured by irradiation in a similar dose range even though morphologic changes are not apparent. It is

also possible that protective agents act on systems other than the hematopoietic, but this remains to be demonstrated.

Survival after lethal doses of irradiation has been achieved in a number of ways. Stimulation of hematopoietic tissues by injection of foreign proteins, by estrogen administration, and by bleeding prior to irradiation has been reported to be effective. Injection of chemical agents such as cysteine and glutathione shortly before irradiation and anoxia in mice during irradiation have protective action. Shielding the surgically exteriorized spleen during total-body irradiation and injection of living blood-forming cells after irradiation afford considerable protection after lethal doses. Jacobson *et al.* (J. Lab. & Clin. Med. **37:** 683, 1951. Abst. in Radiology **58:** 796, 1952) reported a lowering of the mortality rate after intra-abdominal implantation of spleens from normal mice into irradiated mice. The present report describes the histopathologic findings following administration of suspensions of bone marrow from normal animals to mice and guinea-pigs which had been subjected to irradiation with LD 100 doses.

Lorenz *et al.* (Radiology **58:** 863, June 1952) have previously described the technic of study and the survival rates in mice and guinea-pigs who received homologous bone-marrow injections a short time after irradiation. Heterologous bone-marrow injections were also investigated. The routes of administration of homologous bone-marrow suspensions were intravenous, intraperitoneal, and intrasplenic. Heterologous bone-marrow suspensions were injected either intravenously or intraperitoneally. Mortality rates were significantly lowered.

The histopathologic aspects of this series are accented in the present report by the same authors. In the groups of irradiated animals treated with bone-marrow injections the destructive action of irradiation on hematopoietic tissues was unaltered, but the regeneration of these tissues was greatly enhanced. This is said to be responsible for their recovery from the acute radiation injury. It seems to be unlikely that the injected cells *repopulate* the blood-forming organs of the recipient animal even though the cells may settle there. The most acceptable hypothesis is that the transplanted living cells produce a chemical substance which stimulates the regeneration of blood-forming tissue. This is called the *humoral theory*. The *"tiding-over" theory* assumes that the injected cells carry on the function of hematopoiesis until the animal's own tissues recover.

Assessment of the worth of this technic awaits the clinical trial of living bone-marrow suspensions in the acute irradiation syndrome in man.

Seventeen photomicrographs; 1 photograph; 2 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Adverse Effect of Cortisone on Marrow Regeneration Following Irradiation. John B. Thiersch, Loretta Conroy, Alexander R. Stevens, Jr., and Clement A. Finch. J. Lab. & Clin. Med. **40:** 174–181, August 1952.

In a variety of diseases, including rheumatic fever, rheumatoid arthritis, lupus erythematosus, and refractory anemia, cortisone has been found to exert a stimulating effect on erythropoiesis as indicated by a granulocytic leukocytosis, thrombocytosis, and reticulocytosis, and by an increase in circulating erythrocytes. The present study was undertaken to determine whether cortisone could assist in the repair of marrow damaged by irradiation.

Rats weighing 200 to 250 gm. were used in the investigation. *Group I:* Thirty-five animals were given 10 mg. of cortisone acetate intramuscularly every day; 3 animals were killed every two days. *Group II:* Two hundred r whole-body irradiation was administered to 38 rats. Beginning on the third day, and every day thereafter for fourteen days, one-half of the animals were given intramuscularly 30,000 units of penicillin and 10 mg. of cortisone; the other animals received penicillin only. Six animals were sacrificed on the third day following irradiation, and 6 animals from each group were sacrificed on the eleventh and twenty-first post-irradiation days. Five days before the final groups were killed, radioiron was injected intravenously into the animals of each group; at the time of death, the radioiron content of the red cells was determined. *Group III:* Sixty rats were given 500 r total-body irradiation and received either cortisone and penicillin or penicillin alone on the same dosage schedule as the animals in the second group. Radioiron was given four days before the termination of the experiment.

In the normal rat cortisone produced a loss of total-body weight, decrease in the size of spleen and the adrenal glands, eosinopenia, and a mild depression of the bone marrow. Irradiated animals suffered a weight loss and marrow damage, followed by repair over a period of three to four weeks. The administration of cortisone to irradiated rats resulted in a more severe weight loss and blood and bone marrow depression than was found with either agent alone. Histologic examination showed a strikingly slower rate of marrow regeneration, and radioiron uptake studies indicated a lower rate of erythropoiesis in the cortisone-treated animals.

Five photomicrographs; 2 tables.

The Relative Biologic Effectiveness of 200 KV and 23.5 MEV (Betatron) X-Radiation. I. Production of Leukopenia in Mice. T. P. Ting, H. E. Johns, and L. B. Jacques. Blood **7:** 826–835, August 1952.

The leukocyte value in the peripheral blood of three different strains of mice was used to determine the relative biologic effectiveness of 200 kv. and 23.5 mev (betatron) x-irradiation. The results in the three strains were similar. A more severe depression of the leukocytes occurred in the animals in the 200-kv. group than in those in the betatron group; when recovery took place it began earlier and progressed more rapidly in the betatron treated mice. The ratio of effectiveness in producing 70 per cent leukocyte reduction, for betatron irradiation to 200-kv. x-irradiation, for the three strains was 0.65. At a dose of 600 r, the majority of the 200-kv. treated mice died within a few days, whereas none of the betatron-treated mice died.

The 200-kv. irradiation produced a depression in lymphocytes of 95 per cent and the betatron a depression of 89 per cent; the corresponding depression for neutrophils was 98 per cent and 52 per cent.

The authors point out that the fact that betatron irradiation is less effective in producing leukopenia may have practical applications in radiotherapy. With betatron therapy it may be possible to administer doses beyond the tolerance limit set for conventional 200-kv. x-irradiation without inviting the same degree of general irradiation injury. The fact that it is the granulocytes

which are spared may increase the tolerance in man, where the granulocytes constitute 70 per cent, the lymphocytes 20 per cent of the leukocytes. This is a reversal of the neutrophil-lymphocyte ratio in mice, with 80 per cent lymphocytes and 20 per cent granulocytes.

Five graphs; 2 tables.

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A Quantitative Dose-Response Study of Lymphoid-Tumor Development in Irradiated C57 Black Mice. Henry S. Kaplan and Mary B. Brown. J. Nat. Cancer Inst. **13:** 185–208, August 1952.

The purpose of the authors has been to conduct an "extensive, integrated experiment designed to study the influence of alterations in total dose, fractionation, and periodicity of irradiation on lymphoid-tumor incidence." The experiments were started in 1949 and involved a total of 1,753 C57 black mice of both sexes, aged 33±3 days at the start of irradiation. The data are based upon observation periods of over 600 days. Previous literature on experimental lymphoid-tumor induction in irradiated mice contains inadequate data on the relationship between dose and incidence, and the authors hope to provide a reference source for further experiments.

The group of mice studied was randomized by litters into 35 treatment groups and these were given a graded course of total-body roentgen doses in single exposures or 2, 4, or 8 equal fractions at intervals of one, four, eight or sixteen days. A 120-kv. beam was usually used with a half-value layer of about 0.3 Cu but due to equipment failure a 140-kv. source was employed in a number of instances.

The report is primarily a statistical study and is well illustrated with pertinent graphs and charts which would have to be consulted in the original. Results are discussed under the headings: (1) incidence and mean latent period, (2) sex variance, (3) litter variance, (4) genetic variance (lymphoma incidence in litters from the same breeding female), and (5) histologic extent of disease.

"The lowest dose employed, 283 r, approaches a minimal effective dose level below which tumor response could not be differentiated from that in nonirradiated mice of this strain. As total dose is increased above this level, there is a gradual increase in tumor incidence, which, for a given total dose, is not affected by daily fractionation. In contrast, fractionated irradiation at intervals of 4 to 8 days yielded a higher incidence, shorter latent period, and significantly steeper probit-regression line, indicating an optimal rhythm of exposure. Increasing the interval to 16 days resulted in a decreased response, especially at lower dose levels. Under all treatment conditions studied, tumor incidence attained a plateau at about 300 days or earlier." The results are in contrast to those for acute radiation mortality, indicating different mechanisms.

Female mice were slightly more susceptible to lymphoma induction by x-rays than were males, especially at high doses. Unlike the results for radiation mortality, there was little variation in response among litters assigned to a certain treatment group. The larger the initial litter size the more susceptible the animals. There was no significant genetic variance.

A total of 566 lymphomas have been recorded and accurate histologic appraisal was made in 534. The thymus is more constantly involved by radiation-induced lymphoid tumors than any other organ, being involved in 526 of 528 thymuses examined. The lungs, lymph nodes, spleen, liver, and kidneys were frequently involved by tumor.

Thirteen graphs; 9 tables.

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Variations in Natural γ-Radiation in Sweden. Rolf M. Sievert and B. Hultqvist. Acta radiol. **37:** 388–398, March–April 1952.

Natural radiation causing ionization and excitation effects in living cells arises mainly from three different sources: cosmic rays, radiation from radioactive elements in the organism itself, and the γ- and β-radiation originating from small amounts of radioactive substances in the earth's surface. Observations of the γ-radiation in sixty-eight houses in Sweden showed that the ionization varied between 5 and 30 ion pairs/cm.^{3} sec. The authors believe a more extensive investigation would give still larger differences. The radiation was lowest in houses of wood construction and highest in those made of brick and concrete. From a study of the data obtained, it appears that natural γ-radiation in Sweden may cause a dose in the human body varying between 0.002 and 0.020 rem/week. According to Russell (1951), the genetic significance of small doses of ionizing radiation in man seems to be more important that was earlier believed. The authors suggest that the variation in background radiation may be of genetic significance.

Two photographs; 3 diagrams; 4 tables.

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Comparative Study of the Primary Effect of Fast Electrons and Roentgen Rays on Tissue Cultures. Henni Gärtner. Strahlentherapie **89:** 26–51, 1952. (In German)

A careful study was made of the effects of 90 kv. x-rays and of 6 mev electrons from a betatron on the mitosis rate of cultures of chicken heart fibroblasts.

At a dose of 500 r (or rep, respectively) and a dose rate of 1000 r/min., the 90 kv. x-rays are twice as effective as the 6 mev electrons. No difference was found at 4,000 r. The different density ionization of these two radiations is believed to be responsible for the observed results.

Three photomicrographs; 24 charts.

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